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Technical Simulation Of The Process Of Reducing The Moisture Content Of Cotton Seeds And Its Analysis

M. Ibragimov

Tashkent Institute Of Irrigation And Agricultural Mechanization Engineers, 39, Kari Niyaziy, Tashkent State, 100000, Uzbekistan

O. K. Matchanov

Tashkent Institute Of Irrigation And Agricultural Mechanization Engineers, 39, Kari Niyaziy, Tashkent State, 100000, Uzbekistan

I. E. Tadjibekova

Tashkent State Agrarian University, 2, University, Tashkent State, 100140, Uzbekistan

F. J. Isakova

Tashkent State Agrarian University, 2, University, Tashkent State, 100140, Uzbekistan

ABSTRACT: To reduce the technical humidity of cotton seeds according to standard requirements, the method of electric contact heating was used. To reduce the moisture content of seeds under the influence of electric contact heating and convective ventilation in the chamber, a computer simulation model of heat and mass transfer processes in the seed layer was created. The simulation model was developed using the Simulink software.

KEYWORDS: Studies, methods, technical seed layer, humidity reducing, Simulink software, dehumidification.

INTRODUCTION

When conducting experimental studies, methods of mathematical planning of research are used in order to obtain the necessary information about the process under study with spending minimal time and effort for conducting the experiment. The experimental study has the task of constructing a simulation model of the process connected with external influences and the quality of processing object parameters.

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By means of electrocontact processing, special experimental studies will need to be carried out to estimate the moisture yield value according to the main parameters and to optimize the process to reduce seed moisture and reduce lintration time[1,8,19]

Taking into account the requirements for the preparation of a simulation model of the process, it is necessary to determine the dimensions, as well as to determine the ranges of their variability.

As a result of preliminary studies, the process of reducing moisture is influenced by several factors, the main of which are: screw speed (X_1), air speed (X_2), and sheet temperature (X_3). The seed is a biological object and the indicator of the seed layer constantly changing, so without controlling the indicator of this layer or growth of the seed till the unchangeable size, it is impossible to achieve the desired result for reducing the moisture content of the seed[4,9,14].

This, in turn, can affect productivity negatively. When reducing the moisture content of seeds, you can accurately determine which indicators should be monitored, observing the relationship "external environment" – "technical layer of seeds" – "means of control". It is necessary to define this indicator at the time of the process as the "technical layer of seeds" - the object of control (OK).

Thus, the main task is to reduce the moisture content of the seeds[2,3,5,18].

As the most convenient way of calculating of the process of reducing of the humidity of seeds, the method of contact heating is used, which is based on a simple mechanism of heat and mass transfer. The process of reducing of the humidity is characterized by the following system of equations [17,15]:

$$\frac{\partial t}{\partial \tau} + 3600V \cdot \frac{\partial t}{\partial x} = -\frac{\gamma_3 \cdot C_3}{\gamma_B \cdot C_B} \cdot \frac{\partial Q}{\varepsilon \cdot \partial \tau} - \frac{\gamma_3 \cdot r'}{\gamma_B \cdot C_B \cdot \varepsilon} \cdot \frac{\partial W}{\partial \tau \cdot 100}; \quad (1)$$

$$\frac{\partial t}{\partial \tau} + 3600V \cdot \frac{\partial t}{\partial x} = -\frac{\alpha_q \cdot S_v}{\gamma_B \cdot C_B \cdot \varepsilon} \cdot (t - Q); \quad (2)$$

$$\frac{\partial W}{\partial \tau} = -\frac{\gamma_B \cdot \varepsilon}{10 \cdot \gamma_3} \cdot \left(\frac{\partial d}{\partial \tau} + 3600V \cdot \frac{\partial d}{\partial x}\right); \quad (3)$$

$$\frac{\partial W}{\partial \tau} = -K \cdot (W - W_P), \quad (4)$$

Equation (1) reflects the law of conservation of energy in the process of moisture reducing agent (2) and (3) the law of heat and mass transfer between technical seeds and the moisture recovery agent, (4) the law of conservation of substances.

2. Materials and methods

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The calculation of the reducing of the technical moisture content of the seed using electric contact heating is the most convenient, simplified, step-by-step, mechanism of heat and mass transfer. In the technical seed layer, the step-by-step method of reducing humidity, during the process of reducing the humidity of the elementary layer changes in humidity and temperature over time is based on the sequential calculation [6.11]. The calculation procedure is carried out using a personal computer as follows:

1. Calculation of numbers of thin layers
   $n_P = \frac{H \cdot \gamma_3}{60 \cdot V \cdot \gamma_B}$;
   here *H*– is the height of the thick layer (thickness), m.
2. Calculation of the constancy of humidity reducing
   $A = \frac{C_3}{102 \cdot C_B \cdot \Delta\tau + 0{,}5 \cdot C_3}$; $B = \frac{0{,}01 \cdot r'}{102 \cdot C_B \cdot \Delta\tau + 0{,}5 \cdot C_3}$;
   here $\Delta\tau$– estimated time intervals, h.
3. Calculation of the humidity reducing coefficient
   $K = 5{,}55 \cdot \left(\frac{t_{ji}}{100}\right)^2 - 0{,}796 \cdot \frac{t_{ji}}{100}$;
   here *i* –the order of the thin layer; *j* –number of time intervals.
4. Calculation of moisture of the moisture reducing agent, %:
   $$F_{j,i} = \frac{745 d_{j,i}}{(622 + d_{j,i}) \cdot 10^{0{,}622 + 7{,}5 \cdot \frac{t}{238} + t}};$$
5. Calculation of balance of moisture of the moisture reducing agent
   $$W_{Pj,i} = \left[\frac{ln\left(1/(1 - F_{Pj,i})\right)}{5{,}45 \cdot 10^{-6} \cdot (t + 273)}\right]^{0{,}435};$$
6. Calculation of moisture of the technical seed layer
   $$W_{j,i} = W_{j-1,i} - K\left(W_{j-1,i} - W_{Pj,i}\right) \cdot \Delta\tau;$$
7. Calculation of temperature of the moisture reducing agent extracting from the technical seed layer
   $$t_{j,i} = (1 - A) \cdot t_{j,i-1} + A \cdot Q_{j-1,i} - B\left(W_{j-1,i} - W_{Pj,i}\right) \cdot \Delta\tau;$$
8. Calculation of moisture degree of moisture reducing agent
   $$d_{j,i} = d_{j,i-1} + \frac{K}{10{,}2} \cdot \left(W_{j-1,i} - W_{Pj,i}\right);$$
9. Calculation of temperature of the technical seed layer
   $$Q_{j,i} = \frac{t_{j,i-1} + t_{j,i}}{2};$$

RESULTS AND DISCUSSION

When using electric contact heating for reducing the humidity of the technical seed, the following combination of the initial values of the temperature and humidity of the technical seed and the humidity reducing agent of the technical seed was adopted:

- the moisture of air extraction W_H=19%, W_H= 22% and temperature 20°C, air temperature T =25°C balance of moisture 13%.

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Using the above calculations and transfer functions, under the influence of electric contact heating and convective ventilation in the seed moisture reducing chamber a computer simulation model of seed layer heat and mass transfer processes was created. Simulation model was created using Simulink software (Picture 1).

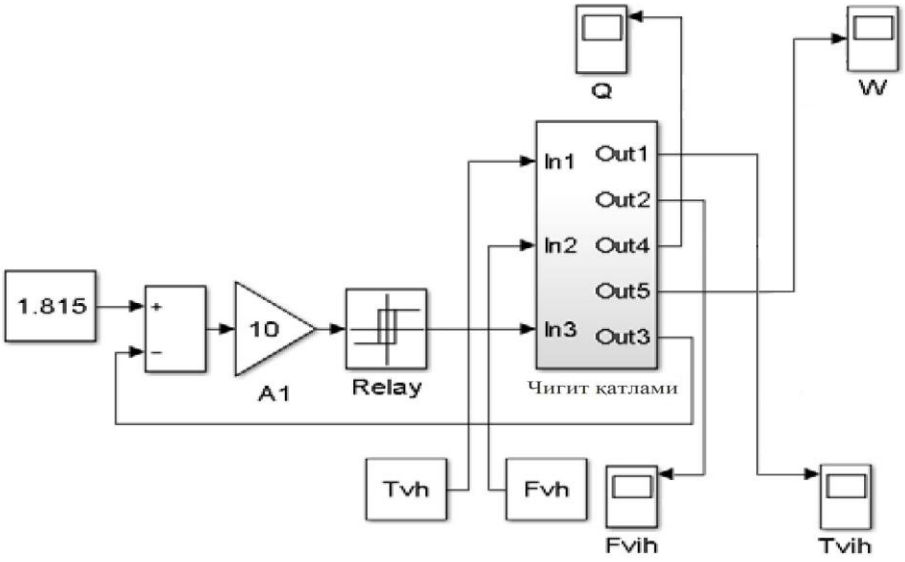

Figure 1. Simulation model of seed layer heat and mass transfer under the influence of electric contact heating and convective ventilation.

Electric contact heating`s thermal energy and convective ventilation heating pass through the seed layer. When the moisture content of the seeds is reduced by the electric contact method, the input indicators are installed by means of the Tvh and Fvh blocks.

The power of the electric contact heating transformer is regulated by the Relay unit. When the temperature in the humidity reduction chamber reaches 700C, the power of the transformer is regulated using the Relay unit. The oscilloscope shows a graph of changes in the temperature of the seed layer (block Q), the moisture content of the seeds (block W), the relative humidity of the air leaving the humidity reduction chamber (Fvih), the temperature of the seeds (Tvih). November was taken for the sample and a graph of changes in the mathematical estimate of the expected air temperature and its relative humidity was taken as preliminary data [7,12]. So, if the estimate of the expected air temperature and its relative humidity changes, the temperature of the moisture reducing agent is artificially regulated. At the same time, in the process of reducing humidity, the relative humidity of the air and it`s temperature is maintained at the level of the established norm. If the inlet air temperature rises

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to 100C, the relative humidity is reduced by 5%. To determine the influence of the layer thickness to the parameter W_(l.a.) the humidity of the moisture reduction agent the calculation for elementary layers is carried out. The thickness of the elementary technical layer of seeds exactly corresponds to the active thickness of the equipment on which the technical seeds are located. The graph of changes in the input and output parameters of the air depending on the total thickness of the technical whig layer and the average humidity of the moisture-absorbing agent at the beginning and at the end of this layer is shown in Picture2.

According to the input air humidity input parameters of the humidity reducing agent (temperature and humidity) is determined using the equilibrium humidity of the technical W_(P.BX.)

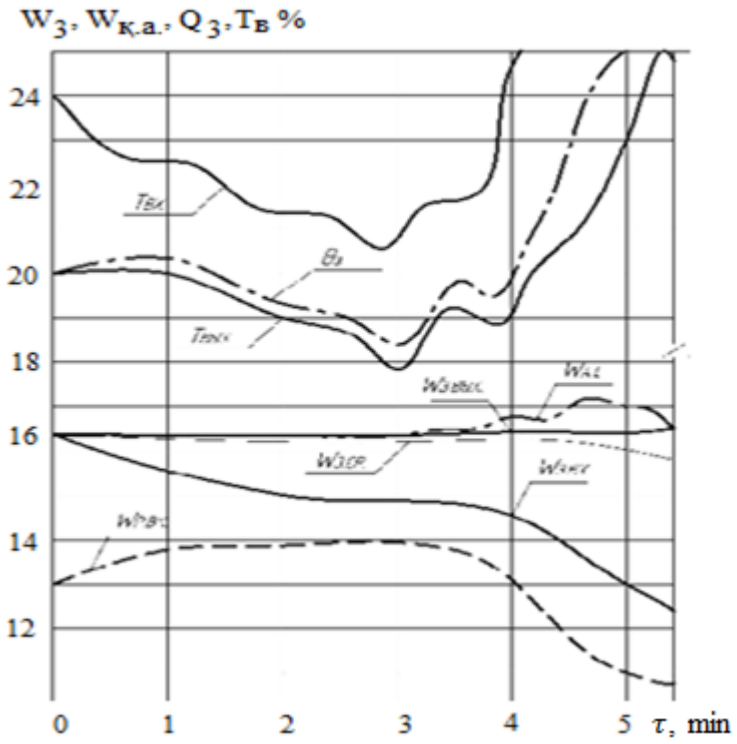

Figure 2. In the process of active dehumidification, the results of modeling changes in the parameters of the technical layer of the seed and the dehumidifying agent are presented. The technical thickness of the seed layer is 0.03 m.

As can be seen from the graph (Fig. 2), the change in the input parameters of atmospheric air has a significant influence on the duration of the technological process[10,12].

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Thus, it is concluded that in order to highlight the full dynamics of the process of reducing the moisture content of the technical seed, it is necessary to fully control the process in accordance with the indicator of the moisture reduction agent [20].

Reducing the technical humidity of the seed is an uneven process, the difference in humidity in the boundary layers does not exceed 0.9%.

CONCLUSION

1. Due to the complexity of expressing the nature of the process of reducing the technical humidity of the seed in the analytical method, the use of modeling methods increases the efficiency of research and gives us to the opportunity justify the proposed equipment indicators.

2. In the case of a decreasing of the humidity of the technical seed layer, the humidity of the incoming air W_(P.BX.) decreases in accordance with the decrease in the average humidity of the layer. First of all, during the process of a moisture-reducing agent, the condensation moisture of the technical seed layer decreases, then in turn the process of alternating soaking and reducing moisture occurs.

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