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The Use of Electroactivated Air to Intensify Grain Drying by Active Ventilation

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Abstract: The post-harvest grain processing process is one of the most important in agricultural production technology. It is post-harvest processing that contributes to the production of high-quality products, long-term and effective preservation of these products, right up to the harvest of a new crop.

Keywords: Drying of wet products, biological activity, Drying, high humidity, recirculating drying, vacuum drying, Electroactivated air, criterion model.

Introduction: One of the main objectives of agricultural production is to increase the production of grain crops to meet the growing food needs of the population.

The post-harvest grain processing process is one of the most important in agricultural production technology. It is post-harvest processing that contributes to the production of high-quality products, long-term and effective preservation of these products, right up to the harvest of a new crop.

Post-harvest grain processing consists of several stages: cleaning, sorting and drying of wet products. The amount of moisture contained in the grain affects its biological activity, quality and safety. This is the most important and reliable factor in regulating the vital activity of grain. In order for the grain to be stored well, its humidity should not exceed the conditioned humidity, which, even in good weather, the humidity of the harvested grain is 4-6% higher than the conditioned humidity. In adverse weather conditions, grain moisture reaches 25-35%. Up to 20% of the crop is lost due to high humidity and inadequate storage conditions. Drying helps to reduce the moisture content of grain, increases its shelf life, but is the most energy-intensive process in post-harvest grain processing.

To obtain grain with conditioned humidity and reduce energy consumption in agricultural production, the following methods of grain drying intensification are used: recirculation drying, preheating, vacuum drying, drying using infrared radiation, drying with high frequency currents, drying grain under the influence of an electric field, and many others. Recently, methods of exposure to dried material with electroactivated air have been increasingly used.

Electroactivated air is used in agriculture for drying, increasing the nutritional value of feed, temporary storage, and disinfection. The analysis of the works showed that the inconsistency of the data obtained by different authors on the concentrations of ozone and aeroions for various technological processes does not allow us to identify the main reasons affecting the efficiency of processing processes. The available research results allow us to talk about the effectiveness of using aeroions to intensify grain drying, but they are also contradictory and require clarification of processing modes.

In this regard, the following ways are outlined to intensify grain drying by active ventilation using electro-activated air:

1. Finding conditions for drying grain by active ventilation using electro activated air.

2. Determination of grain drying conditions by active ventilation using cyclic exposure to electro activated air.

3. Development of grain drying modes by active ventilation using electro activated air.

In accordance with the above, the purpose of the study is formulated in the article.:

Development of energy-saving technology for grain

drying in active ventilation units using electroactivated air.

The object of the study is the process of drying grain with electroactivated air in active ventilation units.

The subject of the study is the patterns of heat and moisture exchange in the grain layer during drying of grain with electro activated air.

The following task has been set:

- To conduct theoretical studies on the description of the effect of electro activated air on the processes of heat and moisture exchange in the grain layer, on the intensification of drying. To formulate a hypothesis about the mechanism of intensification of grain drying using EAW with cyclic supply of aerations. To develop a mathematical model of the drying process of the grain layer under the cyclic action of EAW.

- To conduct comparative experimental studies of grain drying modes under cyclic exposure to EAW.

- To develop regression models describing the processes in the grain layer under cyclic exposure to electro activated air in order to intensify drying.

- To evaluate the economic effect of using cyclic modes of exposure to electroactivated air to intensify grain drying by active ventilation.

Formulated

Working hypothesis:

Activation of the stored energy of the grain, as a biological object, to intensify the grain drying process by active ventilation is possible with cyclic exposure to electro-activated air.

Scientific hypothesis:

An increase in the drying rate of grain and a decrease in the energy intensity of the process is possible due to the activation of the stored energy of the grain, as a biological object, using cyclic modes of external influences.

"Analysis of the issue of intensification of grain drying by active ventilation" describes the need for drying grain during its post-harvest processing. An analysis of grain drying plants, including active ventilation plants, common known methods for intensifying convective drying, and methods for intensifying the grain drying process by active ventilation has been performed. A review of the methods for intensifying the grain drying process using electroactivated air made it possible to assess the prospects of using electroactivated air - aeroions for these purposes. The problems of realization of grain drying by active ventilation using electroactivated air are considered. The mechanisms of heat and moisture exchange in the grain layer during drying are considered, and analytical models of the mechanisms of action of electroactivated air on grain drying are presented. A hypothesis is proposed on the mechanism of intensification of grain drying using EAW with cyclic supply of aeroions. The purpose and objectives of the work are formulated.

The scientific novelty of the research results is represented by:

- a mechanism for intensifying grain drying using EAW with cyclic supply of aerations;

- the criterion dependence of the change in the concentration of ions in the air when using EAV in active ventilation installations, the criterion model of grain drying with electro activated air and the criterion of electro activation of the grain layer during EAV drying;

- equations of the drying rate of the elementary grain layer for the modes of application of the drying agent with a constant concentration of aeroions and with cyclic saturation of aeroions and regression equations based on thermodynamic criteria of the drying process of the elementary grain layer under various modes of use of electro activated air.

Of practical importance are:

- parameters and modes of grain drying by active ventilation using electro activated air;

- a mathematical model of the grain drying process with electro activated air, which makes it possible to optimize the parameters of the active ventilation hopper to

ensure a minimum drying time using electro activated air;

- The results of using cyclic modes of exposure to electro activated air when drying grain with active ventilation: the drying rate increased by 30%, the energy intensity of the process decreased by 21%.

CONCLUSIONS

1. An analysis of the elements of technologies and equipment used for drying grain has shown that cyclic modes of exposure to electro activated air (EAV) with the recommended maximum permissible concentration of aerations at the level of 3.5 • Y10m~3 can be used to intensify the process of active ventilation.

2. A criterion dependence of the change in the concentration of ions in the air when using EAV has been developed in active ventilation installations, and the process criterion model show that in order to reduce the time

10-3 drying cycles can control the concentration of aerations from 0 to 3.5 • 10 m and the duration of the concentration fluctuations from 10 minutes, depending

on the seed culture.

3. Comparative experimental studies of grain drying modes under cyclic exposure to electro activated air and factor analysis of the results made it possible to establish:

- The intensification of EAW grain drying depends on the initial and current grain moisture, temperature and speed of the drying agent. Thus, at an initial grain moisture of 16%, the drying time decreases by 30% and at an initial moisture of 24% - by 13%. At a drying agent temperature of 20 °C, the drying time is reduced by 30% and at a temperature of 34 °C - by 66%;

- a change in the weight coefficients of the temperature of the center and the surface of the grain by no more than 0.2%, with a factor analysis of the grain heating data, allows us to conclude that the change in drying intensity when using EAV cannot be attributed to the temperature effect on moisture exchange;

- a change in the weighting coefficients of the A criterion by 58%, the Ko criterion

by 27%, in the factor analysis of thermodynamic criteria for various drying modes, led to the conclusion that the use of cyclic modes of exposure to EAW leads to increased changes in the moisture content field in the grain, compared with the intensity of the temperature field.

4. The developed mathematical models with a 95% confidence probability adequately reflect the drying process of the elementary grain layer under various modes of application of EAW and show that:

- the use of cyclic modes of changing the concentration of aeroions in the drying agent with an oscillation period of 10 minutes and an aeroion concentration from 0 to 3.5 -1010m-3 is equivalent to an increase in the speed of the drying agent by 2 times compared with the classical method, and by 1.35 times compared with the mode with a constant concentration of aeroions;

- the influence of biological reactions of grains in cyclic mode on reducing the drying time of grain to 30% is confirmed. This effect is equivalent to a 1.3-fold increase in the drying agent rate.

5. An assessment of the economic efficiency of using cyclic modes of EAV exposure to intensify grain drying by active ventilation showed that the productivity of the active ventilation unit increased by 30%, and the energy intensity of the process decreased by 21%.

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