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GRAIN COLD CONDITIONING DEVICE AND TECHNOLOGICAL SOLUTION

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Abstract: The article studies the method of cold conditioning of grain. In the conducted research, a device was developed using intensive moistening of grain, that is, cold conditioning methods. As a result of the data obtained and the conducted research, the device is suitable for use in moistening grain before crushing.

Keywords: grain, grain soaking, hydrothermal treatment, cold conditioning of grain.

Introduction. Over the past 6 years, the world's population growth rate has approached 6%. Therefore, the demand for bread and bakery products is also increasing year by year, and due to the increase in the volume of grain production and the level of flour consumption, special attention is paid to the development and introduction of resource-saving, technically and technologically modernized equipment for moistening the processed flour. However, the lack of modern and resource-saving technologies in the field of high-quality flour production is becoming an urgent problem.

The consumption of more than 100 tons of water for grain moistening in flour production enterprises has had a significant impact on the cost of flour, so flour exports in our country account for 10% of production volume. Industry experts have identified the high cost of water used in the grain moistening process as one of the main factors affecting the quality and price of flour, and the lack of modern technologies in the process and the lack of knowledge of the grain moistening process are the main reasons.

The purpose of this article is to introduce the cold conditioning process of grain as a method of grain moistening in flour processing enterprises in our country and to select the most optimal option for grain moistening, conduct experiments and put it into practice. The most important part of the production process in flour production enterprises is the grain moistening process. The purpose of moistening grain is to moisten the grain, which contains gluten and gliatelin, which after absorbing water into the grain, turns into gluten. Gluten is one of the greatest quality indicators of flour. To increase the gluten content in the grain, it is necessary to moisten high-quality grain. The methods of grain moistening studied in the enterprises where the research was conducted were based on traditional soaking methods. The daily consumption of 117 tons of water for 168 tons of wheat led to a sharp increase in the price of flour. The fact that the market price of locally produced flour was higher than that of imported flour reduced the production performance of the enterprise.

Methodology & empirical analysis. Grain moistening devices have been studied by scientists from a number of countries, including the USA, Ukraine, Russia, China and many others. The studies conducted show that the devices designed for moistening grain were designed taking into account the region and climate. However, due to the climatic

conditions of our country, the method of intensive grain moistening has not been implemented.

Figure 1. Appearance of the grain cold conditioning device

In order to increase the efficiency of the steam humidifier and the speed of cold conditioning of grain, the design of the humidifier was developed, the relative effect of the steam emitted from the special steam-driven blades of the humidifier was mainly used, and the energy- and resource-saving device was developed as an experimental device for cold conditioning of grain in laboratory conditions. The general view of the experimental humidifier is shown in Figure 1.

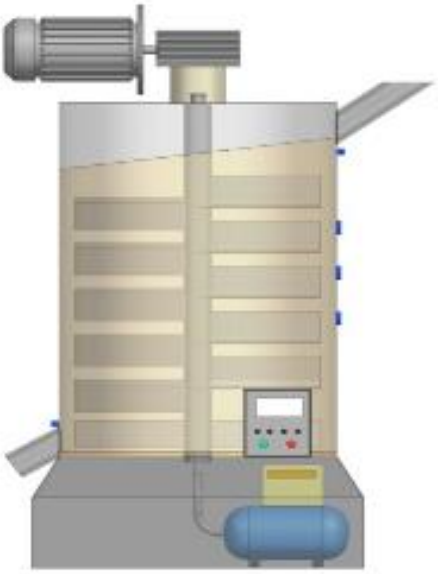

Figure 2. Graphical representation of a grain cold conditioning unit

The purpose of the experiment is to consistently replace the cold conditioning method of grain with a new method, eliminate the shortcomings and energy resource consumption of the current method, reduce the shortcomings and water resource consumption of the current method, and find an optimal solution for cold conditioning of grain.

The experimental humidifier has the following technical specifications:

Productivity, kg/hour	23.3;
Consumption power, kVt	1.5;
Mains voltage, V	220V;
Number of revolutions of the humidification	
device shaft, revolutions/minute	11-18;
Humidifier diameter, mm	500;
Humidifier length, mm	700;
Wetting temperature, °C	
16-22;	
Weight, kg	140;

Results. The flow rate of wheat grains being fed to the grain cold conditioning unit was monitored using a grain flow sensor. The air pressure was selected depending on the initial moisture content of the wheat grains.

$$initial\ weight - dried\ grain\ weight = result \times 20 = final\ humidity$$
$$18.25 - 17.84 \times 20 = 8.2\%$$

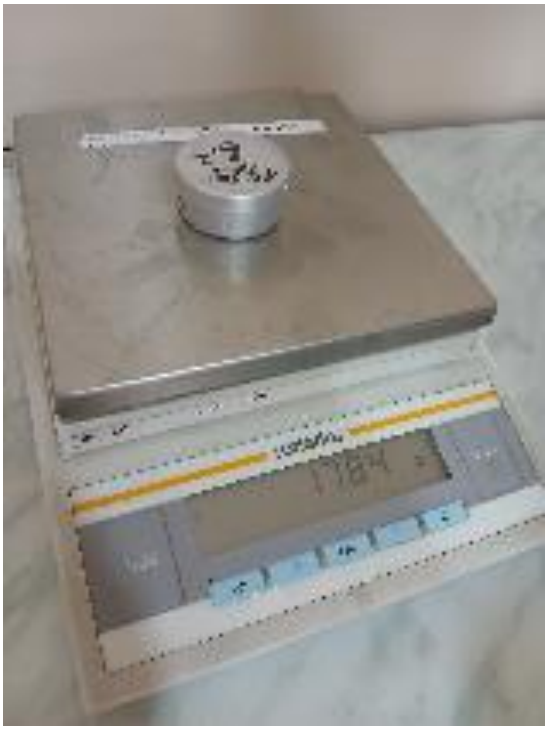

Figure 3. Initial moisture content of grain being moistened in the device

The cold conditioning process of grain was carried out under the air pressure of the device, at the specified speed of rotation of the shaft and the amount of water consumed. The change in grain moisture content during the cold conditioning process is related to the water consumed. It can be described by the following formula;

$$S = \left(M \times \frac{\varphi_{ch}}{100}\right) - \left(M \times \frac{\varphi_k}{100}\right) \quad (1)$$

where: M –is the initial mass of the grain (kg), φ_k –is the initial moisture content (%), φ_{ch} –is the final moisture content %, S –in the required amount pf water (kg).

Initial weight: 140 kg, initial moisture content 8.2%, optimal moisture content 16%, dimensions of the humidification parameters: device height 70 cm, device diameter 50 cm, air pressure 10 MPa. In the first step, we determine the initial moisture content of the grain. Knowing the initial moisture content, the following formula was used to calculate the required amount of water:

$$initial\ humidity \times starting\ weight \div 100\% = dry\ grain\ weight, kg$$
$$Dry\ grain\ weight + Amount\ of\ water\ consumed, S$$
$$8.2\% + 140kg \div 100\% = 11.48$$
$$11.48 + 12.9 = 24.38$$
$$140. + 12.9 = 152.9$$
$$Optimal\ humidity = \frac{24.38}{152.9} \times 100\% = 16\%$$
$$S = 12.9\ kg$$

The amount of water used for optimal grain moisture was found to be 12.9 kg.

Table 1. Time variation of water consumption for grain moisture increase in a grain cold conditioning unit with a rotation speed of 15 times per minute and an air pressure of 9 MPa

№	τ, min.	*enter*	$S_{spend, kg}$	φ_{exit}
1	60	8.2	2.15	9.9
2	120	8.2	4.3	12.2
3	180	8.2	6.45	13.8
4	240	8.2	8.6	14.2
5	300	8.2	10.75	15.6
6	360	8.2	12.9	16

Where τ – soaking time, $m_{en,}$ – moisture content of the graion at the entrance to the soaking device, $S_{spend,}$ – the amount of water consumed for soaking the grain, N_2 –final moisture content of 140 kg of wheat was increased from 8.2% to 16% in a cold condition device under a pressure of 9 MPa, the following formulas were used to calculate the optimal moisture content of the grain:

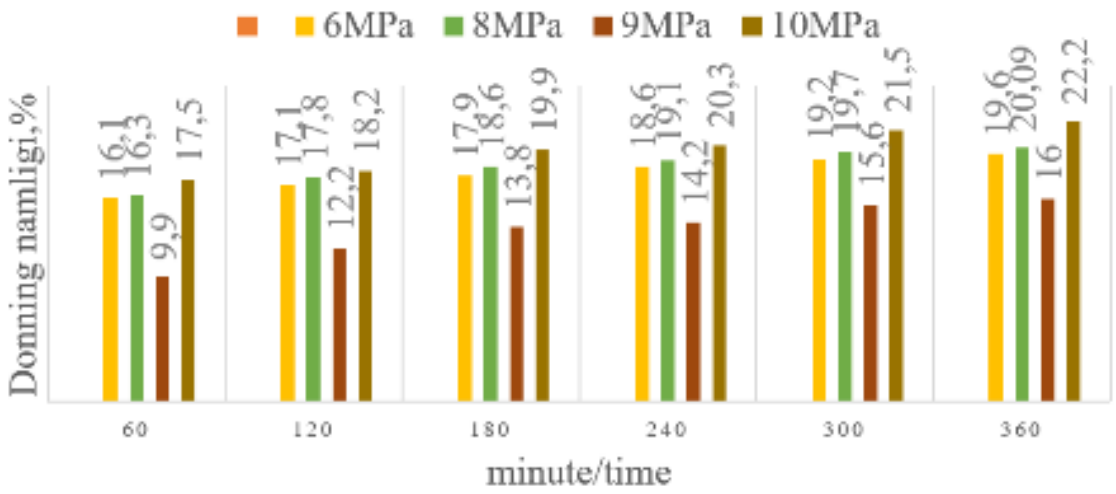

Figure 3. Graph of the results of the rotation of the rotating shaft of the device per minute at different air cross sections

The graphs in the figure show that the mass changes of grains under different conditions are also different. This is due to the grain cold conditioning device's ability to humidify the grain in different modes and under different air pressures.

Experiments and analyses conducted to select the optimal mode show that the time of the experiment should also be taken into account and the electric energy consumption should be reduced when choosing the experimental method. The moisture content of the grain at the inlet is important for this. Therefore, the above factors should be used when selecting the values of the number of revolutions of the device shaft and the air pressure supplied by the compressor.

Table 2. Graph of experimental input factors

T/r	1	2	3	4
z_1	8	9	9	8
z_2	10	10	10	10
z_3	14	13	12	13
z_4	9	9	9	9
Y_φ	16.2%	16.1%	15.1%	15%

Conclusions. In the process of conducting research on the topic "Development of a cold conditioning device for grain at flour production enterprises", the following scientific results were obtained: An in-depth analysis of the conditioning methods and the design of the humidification device was carried out, which made it possible to choose the necessary humidification method and type of humidification device. It was shown that using the combined conditioning method, it is possible to increase the moisture absorption rate and reduce the water consumption of the device. A dynamic model was developed that allows modeling and controlling the process of humidifying wheat grains. Empirical and mathematical models of the conditioning device were developed,

which made it possible to predict the moisture content of wheat grains at the outlet of the device under various humidification mode parameters. An empirical mathematical model of the conditioning device was developed, which made it possible to predict the water consumption of the humidification device due to the presence of water and air spray blades. A method for conducting experimental studies on humidifying wheat grains in the developed vertical shaft-type combined conditioning device was developed. In the developed experimental humidifier, wheat grains were transferred at different shaft rotation speeds.

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