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RESEARCH OF THE PROCESS OF VACUUM COOLING OF BREAD[3]

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Abstract: *The article presents the results of research of the vacuum-evaporating method of cooling bread. It is established that the duration of cooling bread, weighing 0.5 kg, is reduced from 60-90 minutes, when cooling products in an environment with a temperature of 20°C and relative humidity φ = 75%, up to two minutes. The influence of regime parameters of vacuum cooling process on humidity and bread temperature is investigated.*

The magnitude of the vacuum and the intensity of its creation has an important impact on the quality of bread. To ensure the bread temperature within 25 ° C, it is necessary to create a vacuum value of 97 kPa. The mode of creation of vacuum at which integrity of samples which were investigated and high intensity of cooling is provided is offered.

Keywords*: Vacuum cooling, Bread, Heat-mass transfer.*

INTRODUCTION

One of the aspects that improves the quality of finished products in the production of bread is the cooling of freshly baked bread. In most cases, baked bread is cooled on trolleys, which occupy large production areas, and cooling occurs naturally over a long period of time. Coolers are also used in enterprises, which reduce the cooling time due to air conditioning, but occupy a large area.

An improved way to intensify the technological process of food production, including bread, is the use of vacuum evaporative cooling, as its advantages include the speed of the cooling process, compact equipment and a positive impact on product quality.

The use of this method of cooling has been studied for several decades by scientists such as McDonald K., Sun, D.-W, Everington, D., Sluimer, P., Cauvain, S.P. and others.

The process of vacuum-evaporative cooling (VEO) has a positive effect on physicochemical and organoleptic quality of bakery products, increases porosity, specific volume, reduces the time spent on cooling the product, prolongs their storage time due to the absence of infection by microorganisms during cooling [1- 3].

However, the use of the proposed method in cooling rye-wheat hearth bakery products requires additional research to establish the cooling parameters, because due to too intense pressure drop there is a pressure gradient between the steam in the workpiece and the environment,

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accompanied by destruction of the workpiece [4]. Therefore, in order to study the main parameters of vacuum-evaporative cooling of bakery products, we have developed a scheme and design of the experimental installation.

EXPOSITION

Laboratory installation and experimental procedure

The research was carried out on a laboratory installation, the scheme of which is presented in Fig. 1, and consists of: a vacuum chamber with a thermocouple arranged in it connected to a multimeter, an electronic manometer, a moisture extraction system (condenser and condensate collector), a pipeline with valves to regulate the rate of vacuum in the vacuum chamber.

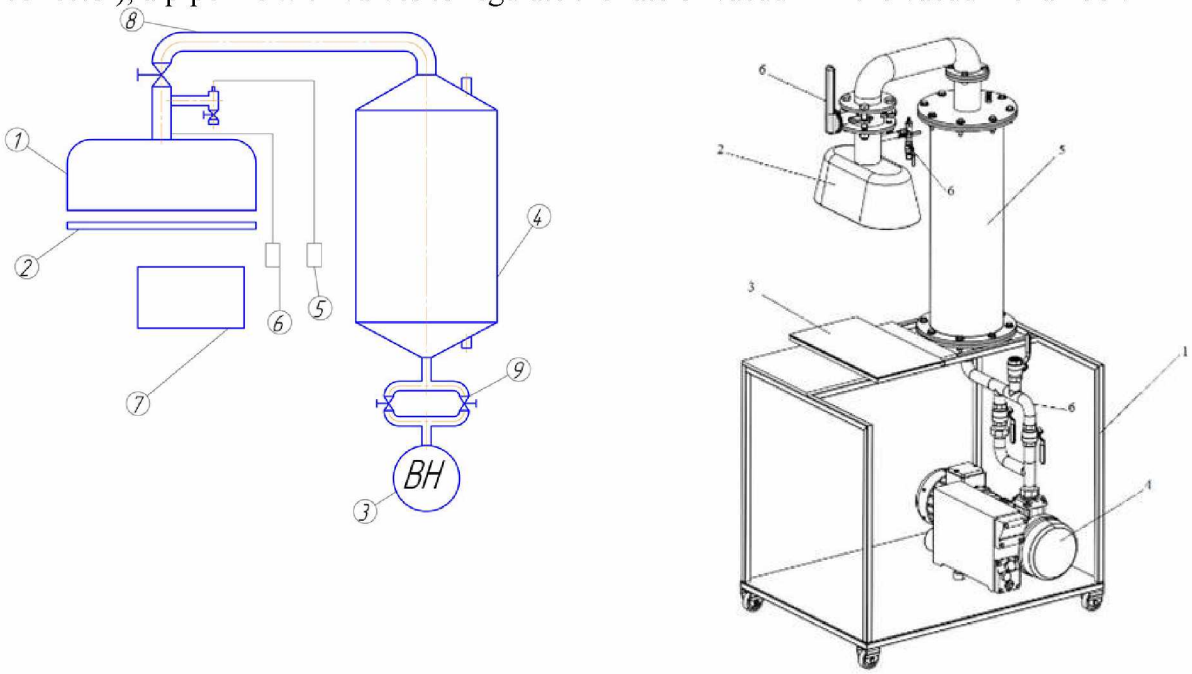

Fig. 1. Scheme of laboratory installation: 1 - vacuum chamber; 2 - vacuum chamber cover; 3 - vacuum pump; 4 - capacitor; 5 - manometer; 6 - multimeter with thermocouple; 7 - scales; 9 - pipeline.

The laboratory unit works as follows: on the lid of the vacuum chamber 2 is placed a blank (hot bread), the lid is applied to the vacuum chamber 1 and the vacuum pump 3 is turned on after reaching the required vacuum (bread temperature corresponds to boiling water at this vacuum) turn off the vacuum pump 3.

An oval hearth bread weighing 0.5 kg and a moisture content of 44% from wheat flour was used as a blank.

Scales are used to determine moisture loss, and a multimeter with a thermocouple is used to determine the initial and final temperature.

During the study of the process of vacuum cooling of bread, the following parameters were controlled:

1) initial and final mass (g)
2) initial and final temperature (^{0}C)
3) time of the experiment (sec.)
4) the depth of vacuum in the vacuum chamber (kPa.)

RESULTS AND DISCUSSION

Cooling of bread is an important technological process during which bread reaches such structural-mechanical and physical parameters that allow to carry out high-quality processes of its cutting and packing. The recommended temperature of bread for these processes is considered to be 30 ° C [5].

Since the vacuum-evaporation method of cooling occurs by removing heat by evaporating moisture from the material, the minimum temperature to which bread can be cooled is determined by the depth of vacuum with a sufficient amount of free moisture in the bread.

Given that excessive moisture loss by the workpiece is impractical, the effect of the final pressure of the environment of the vacuum evaporator on the amount of evaporated moisture from the workpiece was investigated.

The results of studies of the effect of the final pressure of the vacuum chamber on the temperature inside the workpiece and the humidity of the finished bread are presented in Fig. 2.

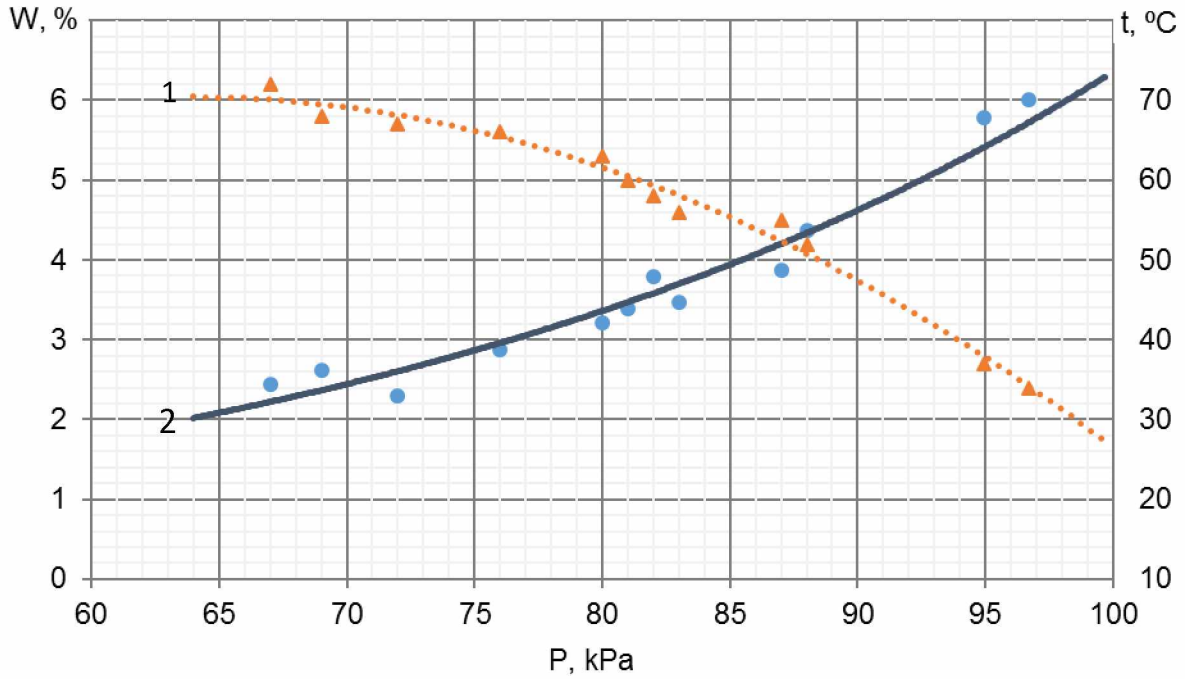

Fig. 2. Dependence of the change in the final temperature of the center of the workpiece (1) and the loss of moisture of the finished products (2) on the amount of vacuum.

From the obtained data it is established that the creation of a vacuum value of 97 kPa is accompanied by a decrease in humidity of the products from 5% to 6%. With the traditional method of cooling, the humidity is reduced by 3… 4%. This also achieves the required temperature for further processing of bread - 30 °C.

Creating a vacuum of more than 97 kPa will lead to overcooling of products and excessive loss of moisture.

In the study of the cooling parameters of oval hearth bread made of wheat flour, it was found that the crust formed during baking has a significant resistance and prevents the diffusion of water vapor from the middle of the workpiece into the environment. In this case, the intensity of cooling will be limited by the capacity of the crust and the strength characteristics of the structure of the bread. When the pressure inside the workpiece is significantly exceeded, there is a stress that leads to deformation of the bread and the destruction of the workpiece (figure 3).

Fig. 3. Destruction of the workpiece

In the course of research work the rational mode of cooling of oval hearth bread from wheat flour to a temperature of 30 ° C was determined (figure 4).

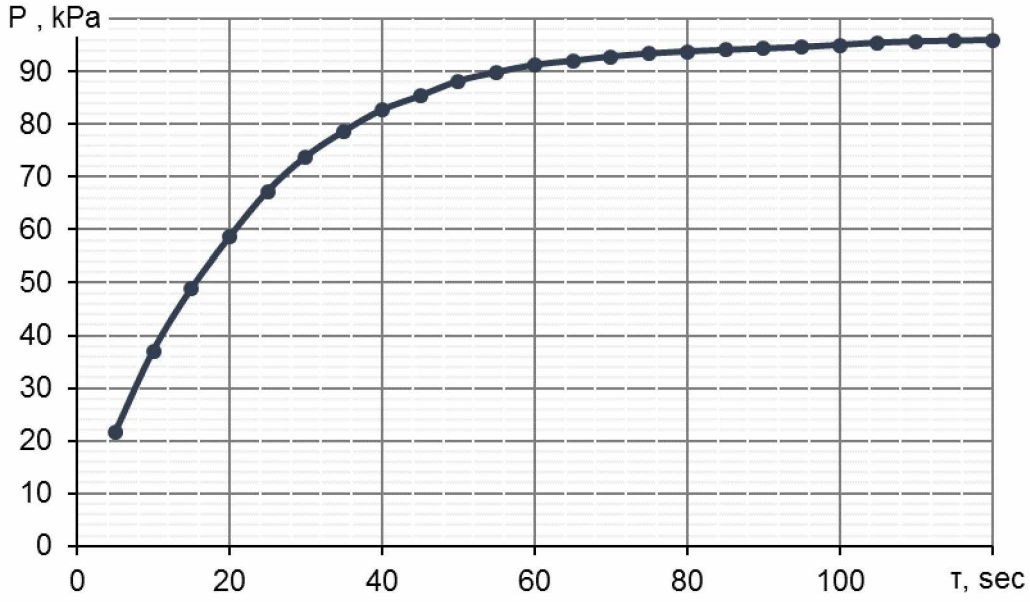

Fig. 4. The mode of creating the vacuum required to cool the bread

In this mode, the cooling time of bread weighing 0.5 kg. is 2 minutes, and the maximum rate of vacuum should not exceed 4.5 kPa / sec.

In this cooling mode, a mixture of steam and air is formed in the vacuum chamber, which is pumped out by a vacuum pump through a system of pipelines. The temperature of this mixture at the outlet of the vacuum chamber in the process of vacuum evaporation cooling is shown on figure 5.

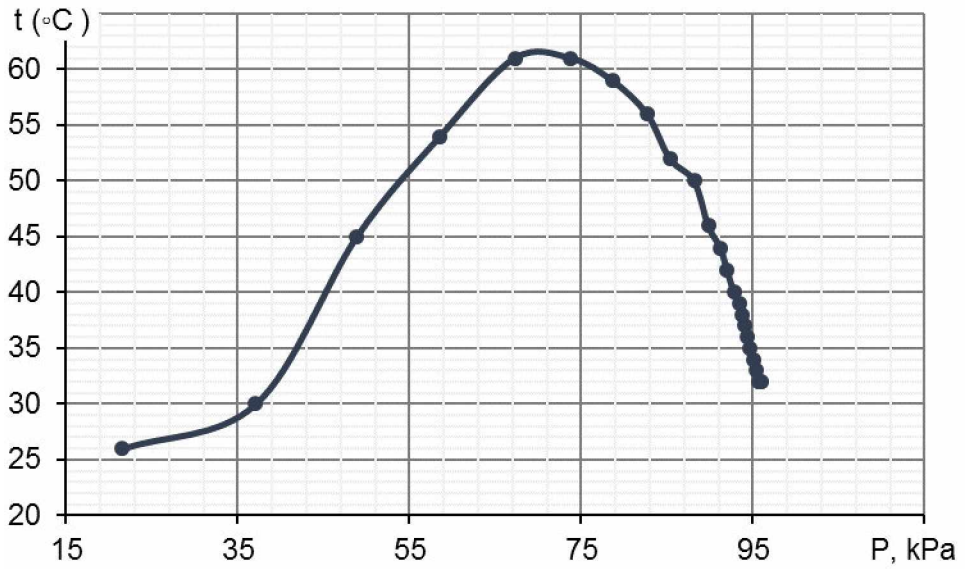

Fig 5. The temperature of the steam stream at the outlet of the vacuum chamber in the process of vacuum cooling of bread

The maximum value of the temperature of the mixture of steam and air during cooling depends on the amount and temperature of air in the vacuum chamber at the beginning of vacuuming.

CONCLUSION

The proposed mode of cooling bread by vacuum evaporation method provides cooling of oval hearth bread weighing 0.5 kg from a temperature of 98 ° C to 30 ° C for 120 sec, Instead of 1.5 - 2 hours. natural cooling, ensuring the integrity of the sample. That allows to receive all advantages of vacuum evaporating cooling, namely reduction of cooling time, improvement of qualitative indicators of products for mass grades of bakery products.

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