Investigation work of proofers by computer simulation

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Abstract

Introduction. Computer modeling can significantly increase the accuracy of study of the air convection processes in the equipment.

Materials and methods. The object of the simulation is a steam-air mixture, which is located inside the proofer. Program used for modeling is FlowVision. The program is based on using the finite element method. It allows graphic data to obtain the temperature of air in its speed, by differential pressure within the structure.

Results and discussion. It was found that in the proofer with vertical movement of the conveyor has an active air convection currents. They lead to the removal of outside proofers warm and moist air. This violates the terms of proofing and dries the surface of the dough pieces. Areas in which convection maximum - is planting windows and technological holes. The reason for its occurrence - the local density difference of cold and warm air. The pictures show the flow of air. Also shows the trajectories of flows of warm, humid air. Observed location of maximum velocity and region of still air. In addition, the causes of convection: the difference in temperature and air density. Observation of the trajectories of air movement allows us to offer a remedy to negative processes.

Conclusions. This study allowed us to propose methods to eliminate design flaws proofers with vertical movement of the conveyor. This will improve the quality of the proofing process with the dough pieces.

Introduction

Proofers include hardware bakeries, which has a long service life. Currently, increased demands on the quality of the finished product and the efficiency of the equipment. Therefore, the important question is its modernization.

The object of the study was elected proofer with vertical conveyor. As before planting them in the oven elongated dough pieces are loosened with carbon dioxide and acquire the shape of the finished product.

This type of proofers available at the bakeries (fig. 1). This is determined by the prevalence of a range of products elongated.

Fig. 1. Typical proofer, appearance

The optimum process conditions proofing - temperature 36 ... 38 ^{o}C and relative humidity within 80%. An important component of providing quality proofing - is to maintain the constancy of these climatic conditions. This need for uniformity of the process of life of yeast cells in the test throughout the entire process, the duration of its 35 ... 60 minutes.

Existing proofers can not always ensure the stability of performance-steam mixture. This is explained as follows: at the time of their design has not yet been possible to model the convection currents inside the proofers with the help of computer technology.

In existing designs swings in temperature and humidity significant. The height of the cabinet up to 5...6 meters, so there are active within the vertical convection currents. This leads to temperature changes in certain areas - up to 10 ^{o}C.

Currently, most of the opportunity to upgrade technological equipment food industry using the means of computer simulation [1, 2, 3, 9]. Preferred method in this area is the finite element method [4].

For proofers important to get a visual and numerical information about air currents [5 - 7, 15, 16]. This will find a place in the structure where the large difference of the parameters. After analyzing the situation to offer methods of eliminating deficiencies. The next step - calculation of new models, as amended. This method allows you to check the correctness of the decisions taken at the stage of design development of modernization.

Materials and methods

In modern conditions it has become possible to upgrade most of the types of technological equipment for food industry through the use of means of computer simulation.

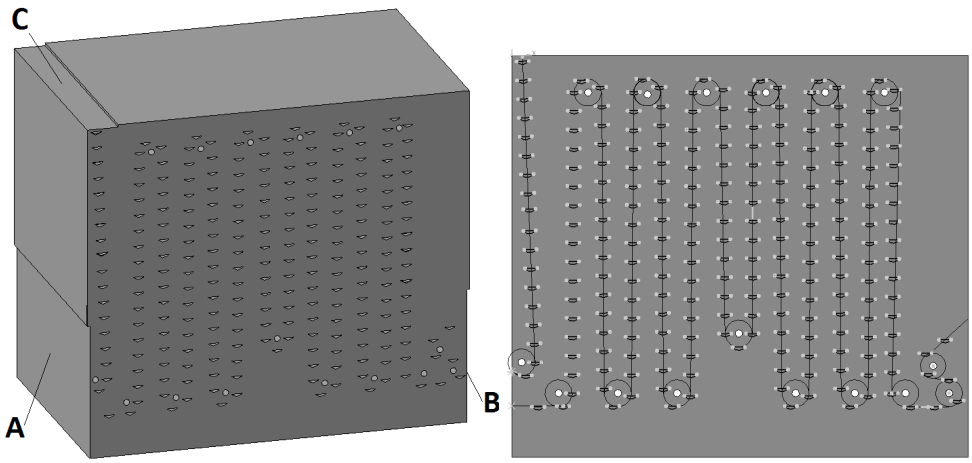
Used for modeling software application package FlowVision. He designed for the simulation of movement the fluids in technical objects. Its working principle is based on the finite element method [7,10,14,15].

Fig. 2 shows the calculated 3D diagram.

Scheme identified three major areas that affect the movement of air within the proofers. Plot A - landing window, through it happens entrance cradles in the closet. The temperature of the air that is sucked into the closet, equal to the temperature of air in the works - Over 25 ^{o}C.

Plot is window for transplant cradles on a tunelnoï oven. The air temperature in the area increased is over 40 ^{o}C.

Section C - processing window through which the cradle includes a bachelor branch in the middle of the proofer.



a *b*

Fig. 2. The calculation model proofer RSV:
a - three-dimensional model with sites of entry and exit of air,
b - longitudinal section with motion paths platforms.

Results and discussion

Consider the conditions proofer RSV in the closet.

Fig. 3 shows the trajectory of the air inside the proofer.

You can draw the following conclusions.

Technological holes (areas 1, 2 and 3) form an interconnected system of sustainable convective air movement.

Input air in the enclosure is divided into two streams. In the lower part flows directed towards the window (regions 4 and 5).

At the vertical side wall of the furnace, in the highest temperature region (region 6), formed stable vertical flow of heated air.

Under the ceiling of the cabinet (area 7) observed horizontal flow of heated air in the direction of the door.

The presence of holes in the ceiling of the proofer is the determining cause of active convection. We can assume that this is one of the biggest drawbacks of this type of proofers.

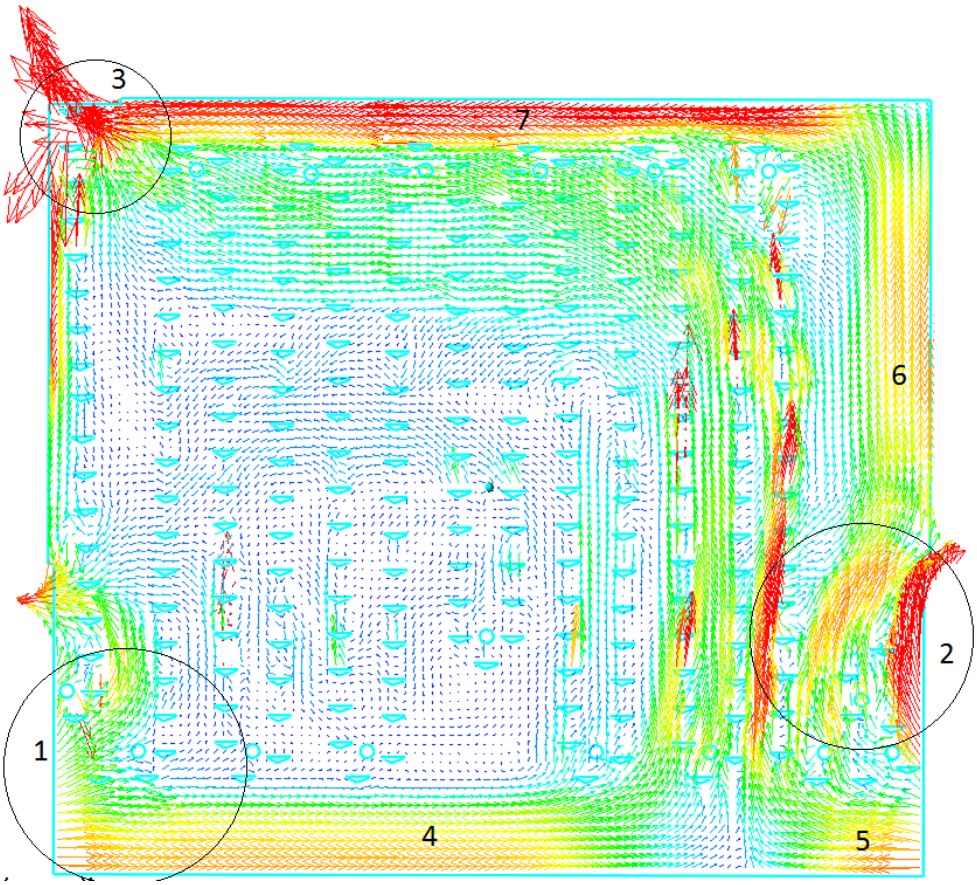


Fig. 3. The air velocity vectors in the proofer RSV

Fig. 4. It shows the air flow in the proofer RSV a trajectory.

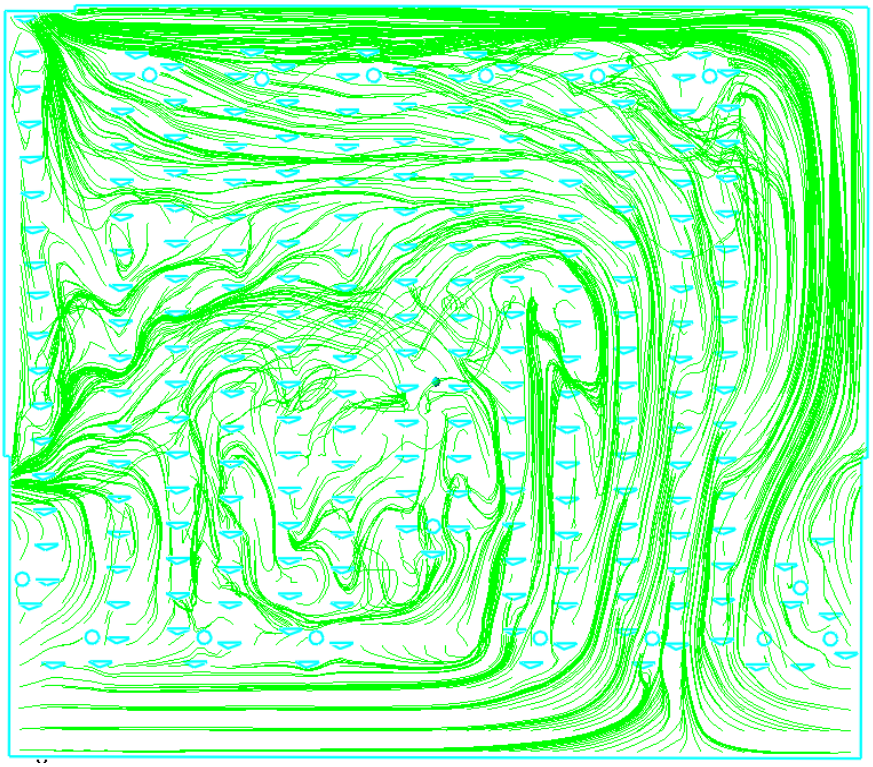


Fig. 4. The trajectories of the air in the proofer RSV.

It can be concluded, in the closet, there are two types of convective currents: a closed-loop and cross-cutting. The last carried out of the closet warm and humid air. It also shows that in the cradle with the dough pieces during his stay in the closet on the sides of the air blown by varying the speed and temperature. Such conditions adversely affect the uniformity of conditions proofing.

If we analyze the temperature difference of the air inside the proofer (Fig. 4), we can see that the movement of the vertical cradles and they always get in low and high temperatures.

Last 5...10 minutes proofing process occur in as quickly and hot air flow (right panel). These conditions lead to the drying up of the surface of the dough pieces.

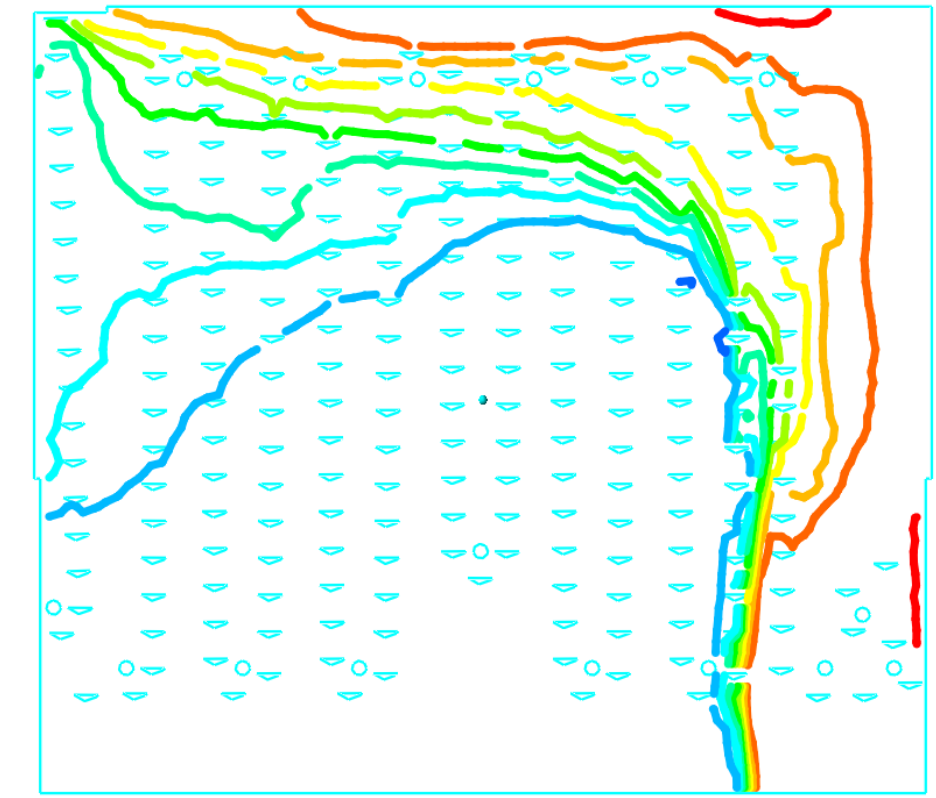
Fig. 6 shows the contours of the differential density of the air inside the proofer. They show the cause of the rising convective air flows. The figure shows that in the closet, there are several areas with different aerodynamic characteristics, that is, there is no stability proofing process conditions.

The results of computer simulation of air flow in the proofer allowed to visualize technological and aerodynamic conditions. At the moment, the opportunity to make the following proposals to modernize the structure of the proofer.

To reduce the activity of the convective air flow is necessary to close the air exhaust path through an opening in the ceiling structure. For existing proofer recommended idle branch cradles close boxes, and include it in the total volume of the enclosure.

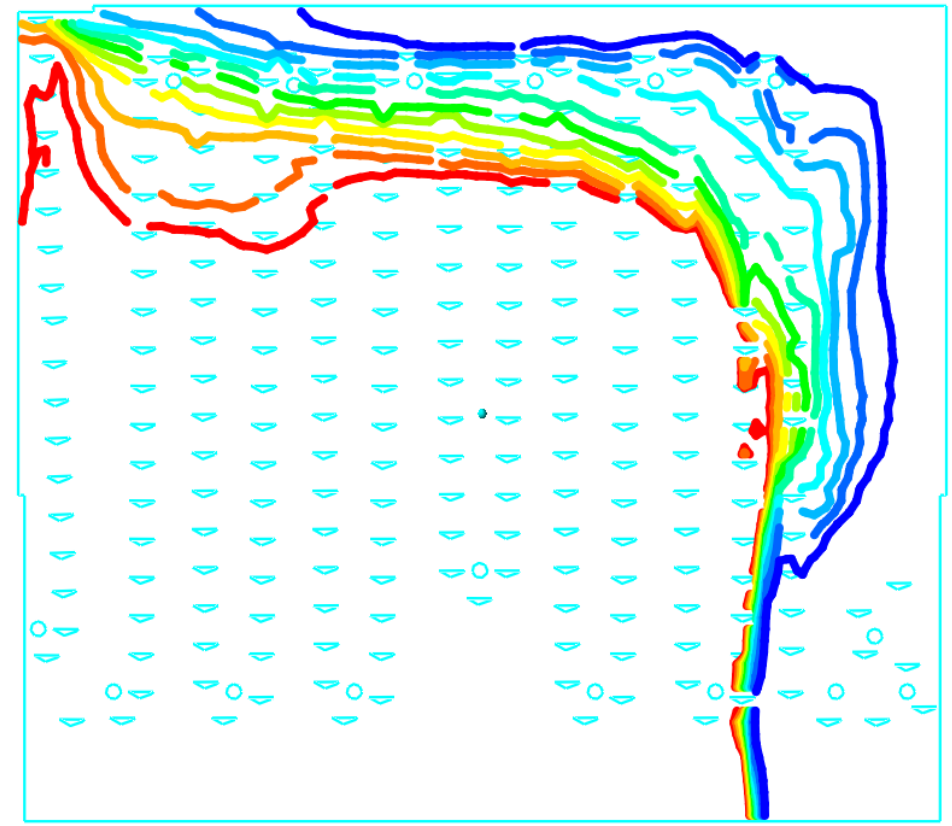
Convective air movement in this case will not go away - it is determined by a large high design. But it will be closed. This will reduce the loss of warm moist environment proofers and reduce its drop.

The basic design of the proofer RSV open divorced branch needed drying empty cradles. In this new process conditions can be achieved by setting the upper part of the cabinet of infrared emitters.



Color	Temperature, deg. C.
	40
	38.2
	36.4
	34.6
	32.8
	31
	29.2
	27.4
	25.6
	23.8
	22

Fig. 5. Isolines of the air temperature inside the proofer



Color	Air density, kg/m^3
	1.07
	1.067
	1.064
	1.061
	1.058
	1.055
	1.052
	1.049
	1.046
	1.043
	1.04

Fig. 6.
Isolines of the density of air in the proofer

Conclusions

Featured studies illustrate that computer simulation gives qualitative and quantitative characteristics of the processes that occur in the proofer with vertical motion platforms.

Analysis of the results makes it possible to reasonably suggest any necessary modifications to this equipment.

Reduction of convective air loss after upgrading will improve the quality of a large number of cabinets RSHV that currently operate the food industry.

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