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USE OF COMPUTER MODELING FOR MODERNIZATION OF FINAL PROOFERS OF PREPARATION OF DOUGH

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Summary: *One of the tasks of modern science in the field of food industry is the improvement of existing equipment. The article presents the opportunity to optimize existing equipment rising of bread dough - proofer. It is used in computer modeling and simulation environment in the Flow Vision. The possibilities for improving the performance of proofer through changes in structure. The studies of the researched example show, that computer modeling allows receiving qualitative and quantitative characteristics of the processes, which occur in the equipment of the baking industry.*

Keywords: *modeling, simulation, proofer, optimization, bread.*

1. INTRODUCTION

Feature of the technological equipment in the baking industry is that it has a long life operation period. This is explained by the large safety factor of strength of items of equipment. Therefore, there are situations in which some items of technological lines have been replaced by more sophisticated, but some have to be operated much longer.

Important is this equipment, which is not old either moral nor physically, to satisfy the new higher requirements for quality of production and reliability of work.

Typical example of equipment, working in different bakery factories for decades is the final proofers. In them, before entering the furnace, the preparations of dough blow of the carbonated dioxide and take the form of a finished article.

Preparation of dough has to be in the whole time (35 to 60 minutes) at constant temperature indicators (36^0-38^0) and relative humidity (round 80%). Therefore, the major requirements for the type of equipment consist creating facilities for realizing the proofing process: uniform distribution of warm moist air throughout the volume of the final proofer.

Final proofers, constructed and installed in the past decade, can't always provide stable indicators of steam-air mix. This is explained by the lack of means for calculating and modeling of convective stream inside the final proofer, when they are designed. This is very important, because the difference in the heights reach 5-6 meters, the differences in the temperature in the different areas – to 10^o.

In the present moment there is a possibility to modernize a big part of the constructions of final proofers, if the means of computer modeling are applied. Calculating and visualization of air streams let us find unfavorable locations in the construction, where the difference in parameters is big.

After analyzing the situation new estimated models with already made changes were also created, which allow the correctness of accepted solutions to be checked at the design stage.

2. COMPUTER MODELING

A method for modernization of final proofers of the disseminated final proofer constructions with horizontal arrangement of the conveyor with cradles for dough preparations will be analyzed. The final proofer works together with a tunnel furnace.
The major areas of thermal emission, which influence the moving of air stream in the final proofer, are these: station to supply stream, station for putting the preparation on the floor of the furnace, located above the hot grid, horizontal area, located above the upper horizontal grid, and fenny furnace.

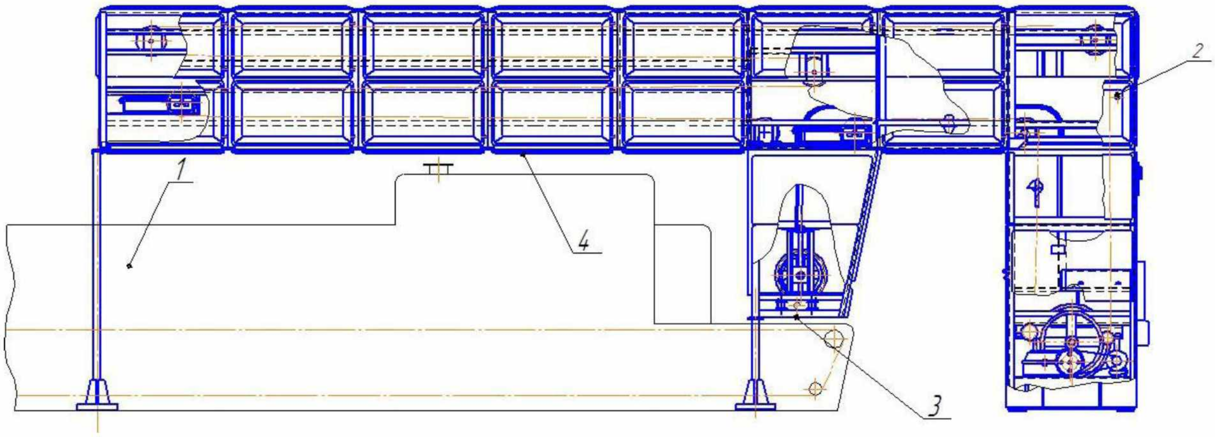


Figure 1: Example for composition of final proofer and furnace with the major stations of heat transfer shown: 1 - the tunnel furnace, 2 – a pipe submission pair, 3 – station for putting the preparation on the floor of the furnace, 4 – station with higher heat transfer from furnaces.

For modeling is used the program package FlowVision, designed for modeling of three dimension flows of liquids and gases in technical and natural objects. In fig.2 is presented a estimated 3D computation scheme, which is imported in FlowVision.

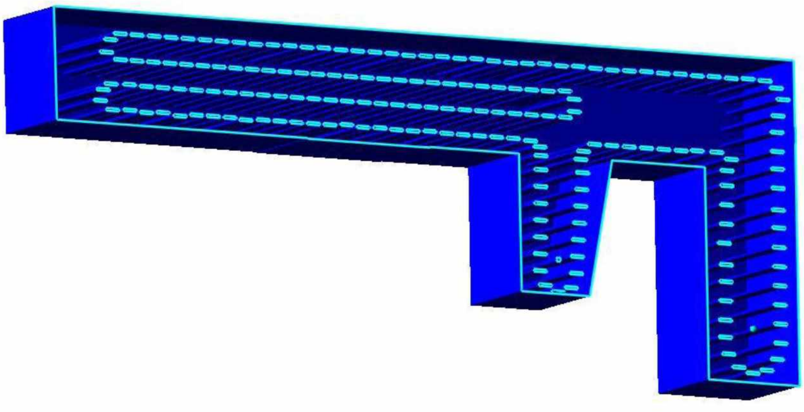


Figure 2: Geometrical model of final proffers (in a cut)

As we see in fig. 2 the major obstacle for free convention of air is created by the suspended cradles, which the dough lie on.
For the separate horizontal and vertical surfaces are put different temperatures depending on presence of sources of heat. In fig.3 in a form of fill graduated colors is presented the temperature field in the final proofer before modernization.
In fig.3 are visible the zones, in which the temperatures significantly differ. The left part of the final proofer practically doesn't get external heat. The area of supplying the steam (up right) creates a superfluous thermal steam, under which there is a stagnation zone without heating. These factors break the uniformity of running the process of final proofers.
In fig.4 using vectors is shown the field of speeds of air in the final proofer before modernization.

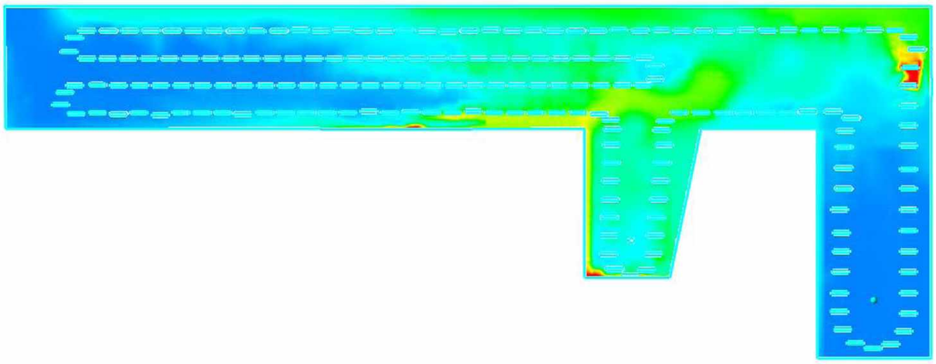


Figure 3: Distribution of temperature before modernization

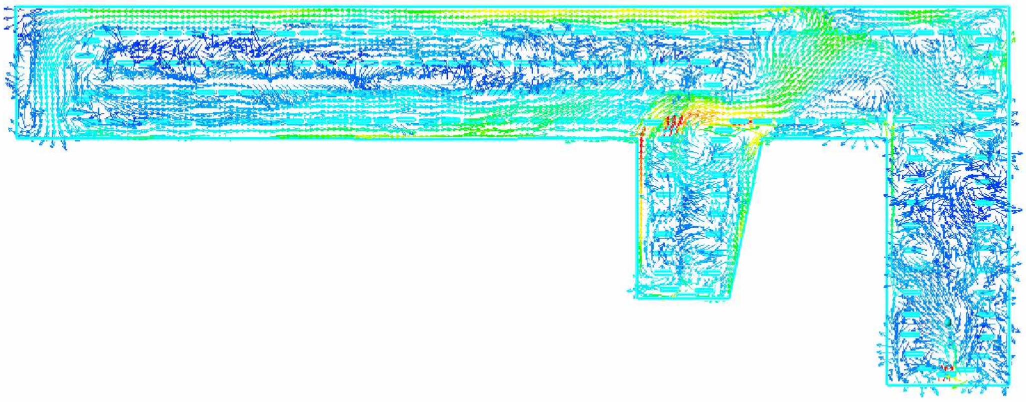


Figure 4: Distribution of air speed before modernization

In fig. 4 are visible the zones, where the intensity of air stream significantly differ. The highest speeds of convection are in the middle part of the final proofer, located above the hot floor with maximal heat transfer. In the other part of the final proofer the convection is minor and the steam-air mix becomes difficult.
In fig. 5 is visualized the trajectory of separate particles of air. Computer modeling allows the presence of stagnant areas inside the construction to be shown.

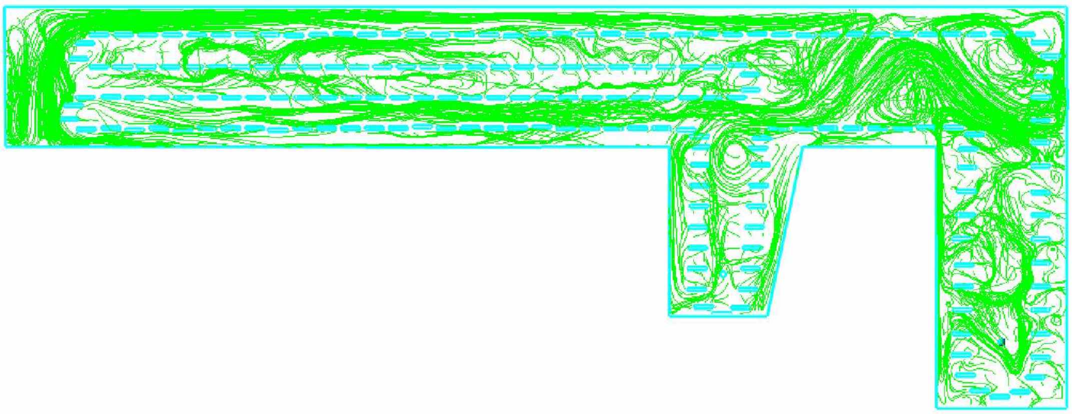


Figure 5: Trajectory of air flows before modernization

3. RESULTS OF MODELING

Convention of steam-air environment inside the final proofer is a positive factor in the process of final proofing, because with its help are leveled the temperature and humidity conditions in the final proofer. There are parts of the final proofer, in which the convection is small, which leads to big differences in the temperature.

The analyze of the received results gives us the opportunity to estimate the activity of circulation of air inside the final proofer and to determine, that equal conditions for final proofing cannot be reached. We can make a conclusion, that it is necessary to innovate the construction of final proofers, so that the existing disadvantages can be eliminated.

The directions of modernization are the following:

-Eliminating the stagnation zones (zones with small air circulation)

-Activation of convection

-Ordering convection.

Practically the modernization will be realized in the following stages:

-Displacement of pipe 1 for submission of steam in the lower part of the final proofer, so that ascending area of heating can be activated

-Installing additional pipe for steam submission in area 2, so that an additional area of heating can be created

-Installing rotary reflectors of air streams in areas 3 and 4, which will allow to helm the air stream in areas with weak convection

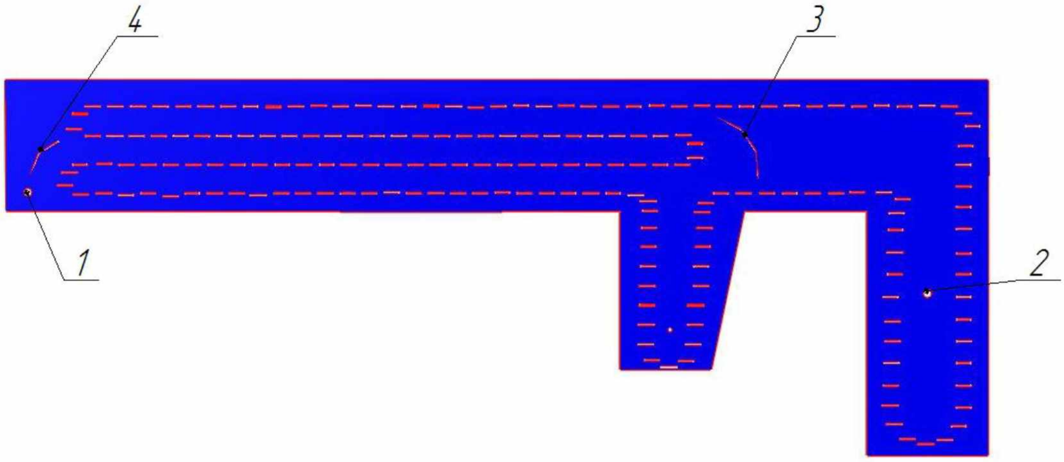


Figure 6: Areas of modernization of final proofer: 1 and 2 – pipes for steam submission, 3 and 4 - rotary reflectors of air stream

After making the innovations in the model the calculations were repeated and the results are adduced in the following figures.

Inequality in distribution of temperature is kept, which is determined by the construction of the final proofer itself: disposal in horizontal direction and areas, geometrically limited by the chain conveyor with cradles which prevents circulation of air.

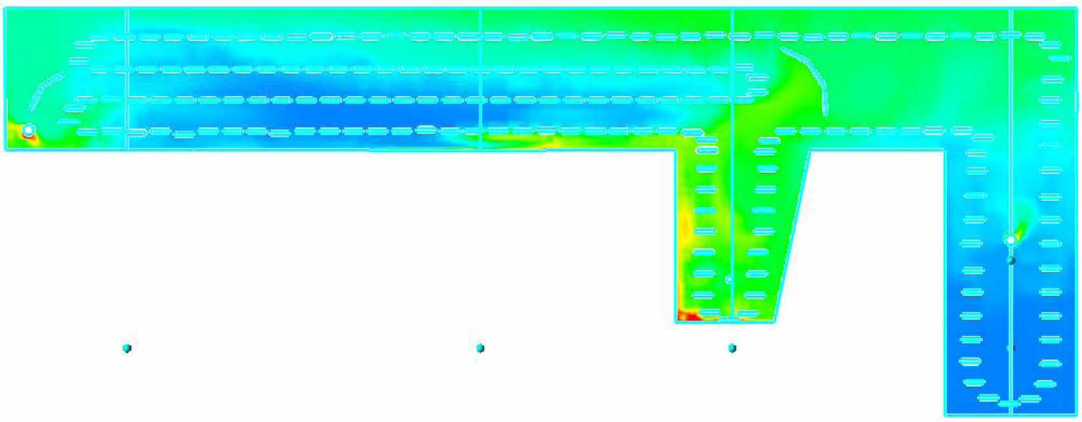


Figure 7: Distribution of temperature after modernization

Speeds of air stream became more equal and the air is directed also to areas where couldn't reach earlier (fig.8).

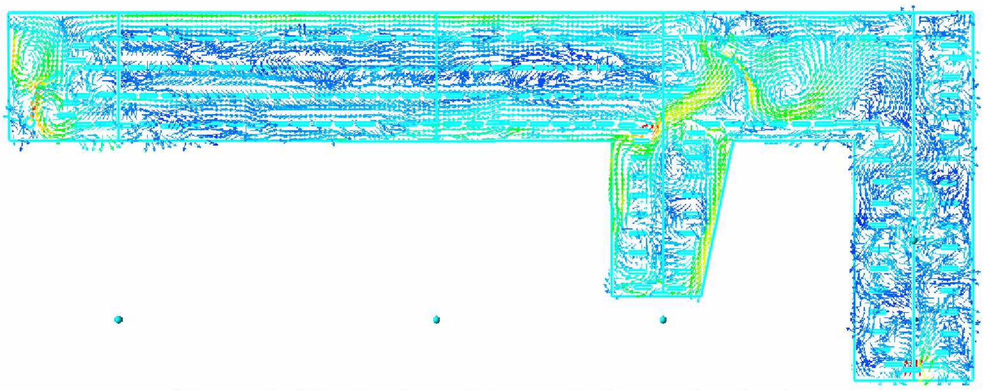


Figure 8: Distribution of air speed after modernization

The image of air circulation is more saturated (fig.9). This shows, that there is an amplification of convective streams.

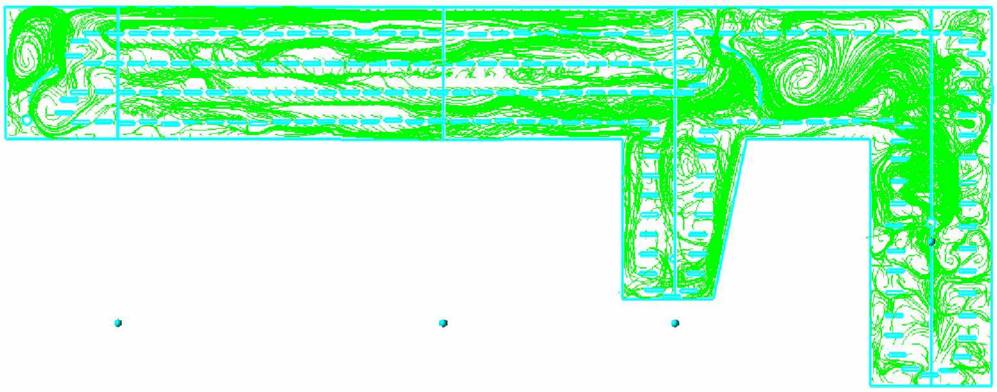
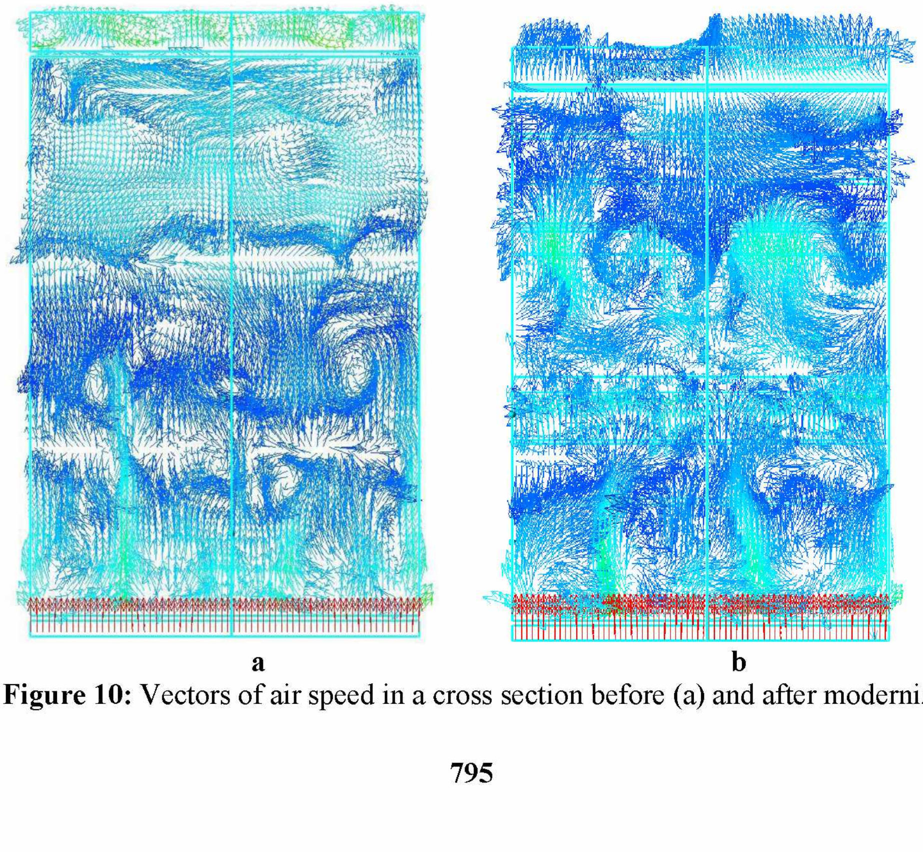


Figure 9: Trajectory of air streams after modernization

In fig. 10 for comparison are shown two cross-sections of the final proofer in the area of loading the dough preparations before (fig. 10 a) and after modernization (fig.10 b). The images are received at identical density of presentation of vectors.



a **b**

Figure 10: Vectors of air speed in a cross section before (a) and after modernization (b)

The analyze of the figure allows making a conclusion, that convection after modernization considerably increases. This leads to active interfusion in the final proofer, which equalizes heat and humidity indicators in the whole volume.

3. CONCLUSION

The studies of the researched example show, that computer modeling allows receiving qualitative and quantitative characteristics of the processes, which occur in the equipment of the baking industry.
After analyzing the received results changes in the construction were made. Checking the accuracy of the solutions is done with a second modeling. If it is needed, the quantity of the stages of modeling could be increased, which could contribute the gradually increase of the quality of modernization.

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