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STRUCTURAL AND PARAMETRIC SYNTHESIS OF KNEADING MACHINES

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Abstract: *It are offered methods of analysis and research of hydrodynamic processes in kneading machines. In modern conditions, a qualitative full-fledged study of complex hydrodynamic processes that occur during the movement of the working bodies of the mixing equipment is impossible without the use of computer technology. Methods and programs of three-dimensional simulation computer modeling make it possible to obtain quantitative and qualitative characteristics of kinematic and dynamic processes. With the accumulation of a sufficient amount of information, it is possible to synthesize the design of the kneading machine, which will include technical solutions that allow you to create the optimal industrial design for today.*

The analysis of constructions of kneading machines and a technique of research of their work gives the chance to define directions both improvement of work of existing, and to create new variants of a structure.

Keywords: *mixing, bread dough, efficiency, modeling.*

INTRODUCTION

Production of high-quality bakery products depends on the structure and reliable operation of technological equipment. Therefore, the task of creating modern highly efficient equipment of technological lines is relevant today.

Among the equipment of the bakery industry, machines for kneading dough stand out with the greatest variety of designs. This is due to the complexity of the process of primary mixing of bulk and liquid components, the gradual formation of a solid mass of the dough, the development of its spatial structure. Designers from different countries offer original designs, the structure of which is based on their own theories and technical traditions. The task of the study is to analyze the operation of existing kneading machines, to study the features of the influence of their working bodies on the components of raw materials and to determine the most rational parameters of the kneading process.

EXPOSITION

In modern conditions, a qualitative full-fledged study of complex hydrodynamic processes that occur during the movement of the working bodies of the mixing equipment is impossible without the use of computer technology. Methods and programs of three-dimensional simulation computer modeling make it possible to obtain quantitative and qualitative characteristics of kinematic and dynamic processes. With the accumulation of a sufficient amount of information, it is possible to synthesize the design of the kneading machine, which will contain technical solutions to create the optimal industrial design today.

The research process is divided into separate stages. These are the stages of formation of bread dough, which occur sequentially: the creation of a solid mass, directly kneaded, the development of an elastic structure - plasticization. All of them require different mechanical effects, as the product formed and processed differs significantly in structure and properties. Therefore,

research must be divided into separate stages of modeling, which have their own temporal, rheological and kinematic indicators of the process.

The proposed technique allowed to obtain numerous data on such processes that occur in the mass of non-Newtonian liquid, such as bread dough, when passing through it the working body:

- Velocity distribution by product mass and velocity gradients in the boundary layer;
- The nature of the movement of fluids with the definition of reynolds criteria in its various parts;
- Distribution of the pressures arising at influence of working bodies on a product;
- Energy costs in the boundary layer, which provide a three-dimensional picture of dissipation processes, the analysis of which in turn makes it possible to determine the places of irrational (insufficient or excessive) mechanical impact of the working bodies on the product.

The next stage of the study is the structural analysis and synthesis of structures, taking into account the existing criteria and approaches to obtaining bread dough with the specified technological parameters. Also take into account the technical and economic indicators of the mixing process: energy consumption and process duration.

The software package for FlowVision personal computers from Tesis was used to study the test kneading process. This package is intended for modeling of hydrodynamic processes in technical and natural conditions, and also visualization of these processes by methods of computer graphics. Using different turbulence models, we can simulate complex fluid motions, such as flows with a strong twist and a free surface.

As a result of the experiments, vector fields of velocities and pressures were obtained, as well as turbulent dissipation over the entire volume of the computational domain.

Consider, for example, the determination of the distribution of the velocity of the product in the cylindrical working capacity of the kneading machine with the kneading body in the form of a spiral (Fig. 1).

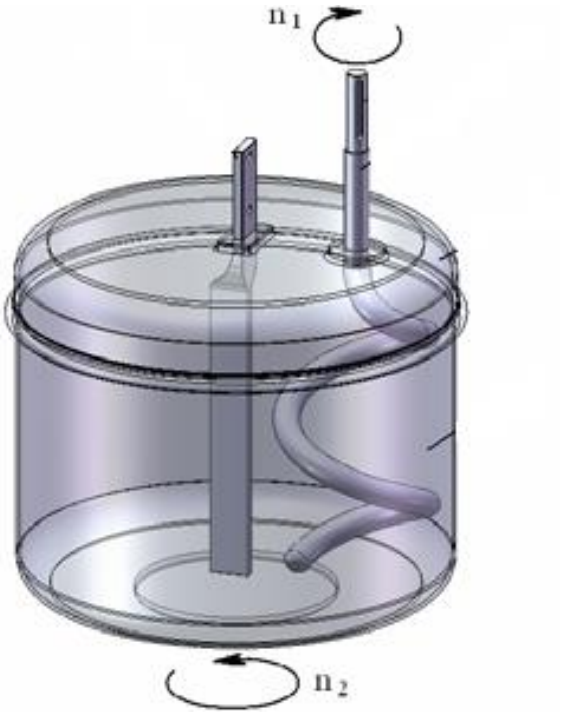

Fig.1 The scheme of the kneading machine

The figures show Fig. 2 the velocity distribution zones in the vertical cross-sectional plane. The simulation was performed for 4 spiral speeds:

Number	Radian speed per second	Area, conventional units
1	4,19	5665
2	6,28	10364
3	8,37	19383
4	10,47	22612

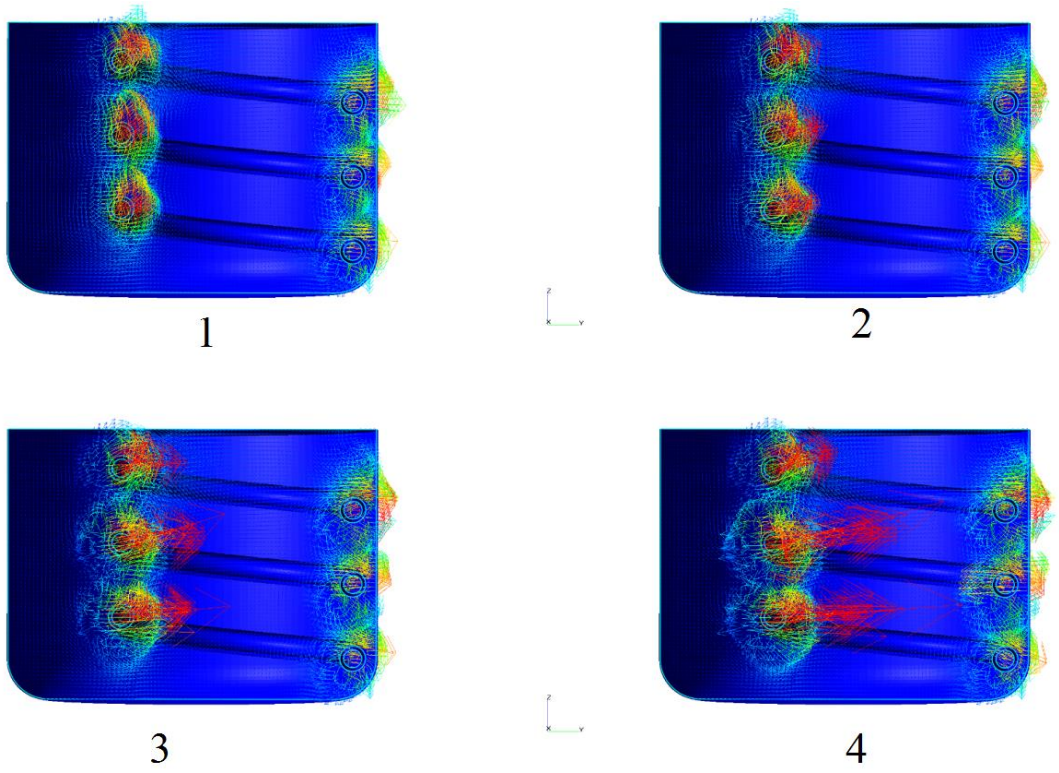

Fig. 2 Areas of influence of the working body on the product

By analyzing the area of equipotential surfaces, the pattern of velocity distribution in the kneading tank, it is possible to estimate where are the largest values of velocity observed in the kneading bodies.

Now we measure the area of vectors of a certain intensity.

In this way, the intensity of the product batch can be estimated.

After carrying out mathematical processing we receive a picture of influence of speed of a working body on intensity of process of kneading of the test (Fig. 3).

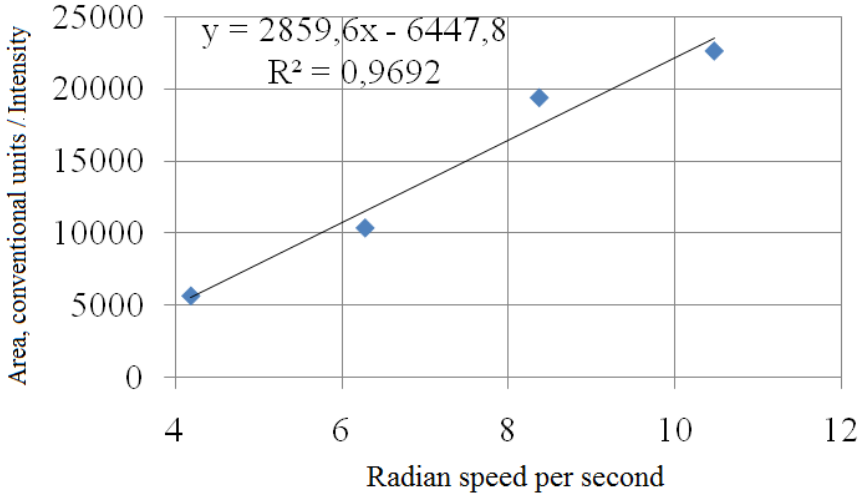

Fig. 3 Dependence of processing intensity on the speed of the working body.

CONCLUSION

The use of computer modeling in the design of new efficient kneading equipment, significantly speeds up the design process. With the help of this method we can design new equipment in a much shorter time, analyze the operation of kneading machines used in enterprises today. When modeling the kneading process, we can establish the inertial and energy characteristics of the process at any point in the kneading volume.

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