Perfection of equipment for improvement of dough semi finished

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Keywords:

Mixing
Dough
Extrusion
Fermentation
Forming

Article history:

Received 22.04.2014
Received in revised form 13.06.2014
Accepted 30.06.2014

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Abstract

Introduction. Improve the process of bread-making is possible through the use of intensive mixing, improvement of its fermentation and formation.

Materials and methods. Investigated wheat yeast dough of white wheat flour(ARS 465) and mixing processes, fermentation and formation of an experimental equipment in which these operations are combined.

Results and discussion. The necessity of complex perfection of process of production of rusk warest comes up from the traditional method of production, wide usage of hand labour and bulky equipment. Design of mixing-fermentation-forming unit, which allows to combine the processes of continuous intensive dough mixing, aerated dough pieces fermentation and formation directly to the baking plate. The unit provides a reduction in car-hardware circuits and reduces the cost to operate the equipment.

Viscosity of the dough is decreasing while the intensity of machining is increasing due to the weakening of connections between the particles of the dough.

Increasing the content of gas phase decreases the viscosity of the dough and increasing the average flow velocity. The quantity of gas greater than 40% and a pressure gradient of 0.3-0.4 MPa lead to destruction of the gas bubbles.

The exponential dependence of the mean flow velocity w on the compaction pressure P, (0,1-0,4) MPa. with different contents of the gas phase G (0 - 45)%

The dependence of the coefficient of the cord dough expansion from the angel of the entrance in the molding channel has the extreme. The optimal value of the taper entrance - 70-80°.

Conclusion. The results should be used in the design of new and reconstruction of existing production lines of bakery products.

Introduction

Lately the expansion of demand and variety of rusk products, especially it touches the wares of small diameter. However for their production traditional technology and equipment are used. Continuous forming of dough cord is interrupted for a portion stowing of flags on sheets for del standing on the cradles of proofers. The duration standing for the rusk sleepers of small diameter in a few times exceeds duration of baking of this sort of rusks, that means that providing of the productivity of stove an area proofers must be in a few times more area of hearth del, and taking into account the small geometrical sizes of wares the volume proofers is used very uneffective.

The practice of baking companies shows widespread adoption of intensive technologies of preparing dough in kneading machines with intense action. Without deterioration of the finished products without dough way to prepare the dough can be successfully used for rusks products.

The disadvantage of crackers in the traditional way is the need of large industrial areas and a large number of production personnel.

Using our proposed method of production and distribution with loosening in dynamic conditions will ensure continuity of process handling dough purveyances.

We have suggested the way for dough separation, which lies in the combining of the processes of molding and loosening of dough blanks in one aggregate by extrusion yeast dough, filled by the carbon dioxide, with no additional stages of dough cords' processing. Its usage requires comprehensive study of influence of geometry parameters of the forming channel on the measures, surface state and the character of porosity of the dough cord and the ready products.

The essence of any process of molding lies in the directed deformation of material with the help of the appropriate instrument. At the molding of extrusion the forming element is matrix, in particular, its channel. Geometry parameters of the channel determine the parameters of the extrudate and the quality of its surface.

Materials and methods

We investigated, the proposed experimental equipment for intensive mixing, which ensured that all three stages of mixing dough. The working body consists of three parts: the tape, screw with variable step.

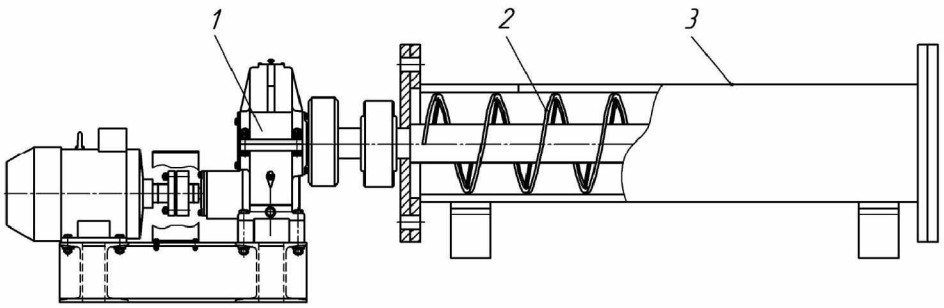

Fig.1. There is a chart of experimental fluidizer research of intensity of treatment of dough.
1 - occasion; 2 - working organ (scruw); 3 - corps.

The main indicator of the structural and mechanical properties the dough is the effective viscosity. We have conducted the research to determine changes in viscosity of the dough, depending on the specific work flow per knead.[2]

For the research of the influence of the geometry parameters of the forming matrix on the process of extrusion of gas filled dough, we have created experimental installation (Fig. 2), which allows to conduct the wide spectrum of the study as kinetic factors: middle speed of the flow, volume, mass production and the dynamic one.

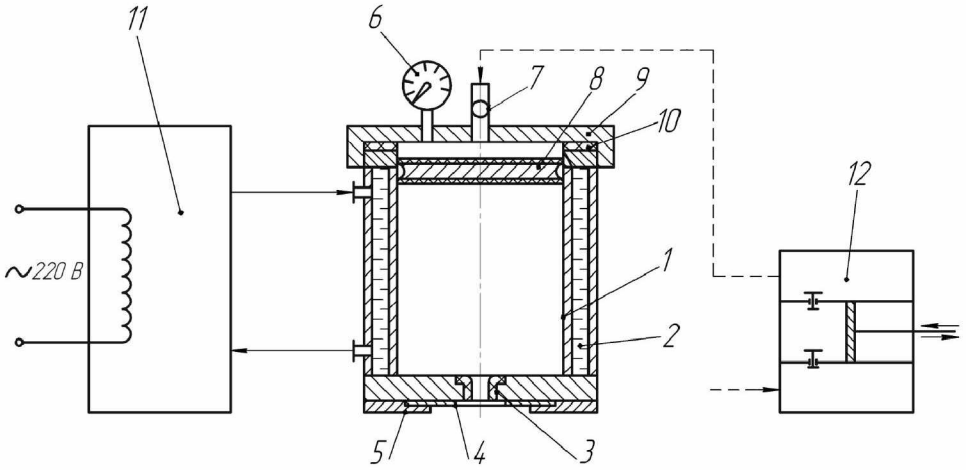

Fig.2. The scheme of the installation for the study of the process of extrusion of the yeast dough.

1 – cylindrical body; 2 – water shirt; 3 – matrix; 4 – knife; 5 – guide yoke; 6 – manometer; 7 – stopping valve; 8 – piston; 9 – cover; 10 – compactor; 11 – ultrathermostat; 12 – compressor.

The influence of the geometry of the forming channel was studies with the usage of the matrix with a various angle of the entrance, exit and the length.[3]

Results and discussion

Analysis of experimental data (Fig.3.) showed that the viscosity of the dough is decreasing while the intensity of machining is increasing due to the weakening of connections between the particles of the dough and the forces of viscosity is overcoming by increasing of the kinetic energy of the molecules.

As a consequence from the experimental data, reducing of viscosity occurs also during the time of fermentation of the dough and especially intensively during the first hours of fermentation. The value of viscosity after 1 hour of fermentation with the consumption of 30 J / g specific work per batch is the same that is during 3 hours of fermentation with consumption of 7.5 J / g specific work per batch. Therefore, changes in the structural and mechanical properties of dough which occurs during the fermentation process due to repeated stretching during the formation of gas bubbles can be achieved by intensive mechanical treatment of the dough during kneading.

Application of the intensive mechanical treatment during the dough mixing process allows to reduces the process of fermentation of the dough and to distribute yeast cells more uniformly throughout the whole volume of the dough, which promotes the formation of more centers of gassing and obtain a uniform fine-pored structure finished products.

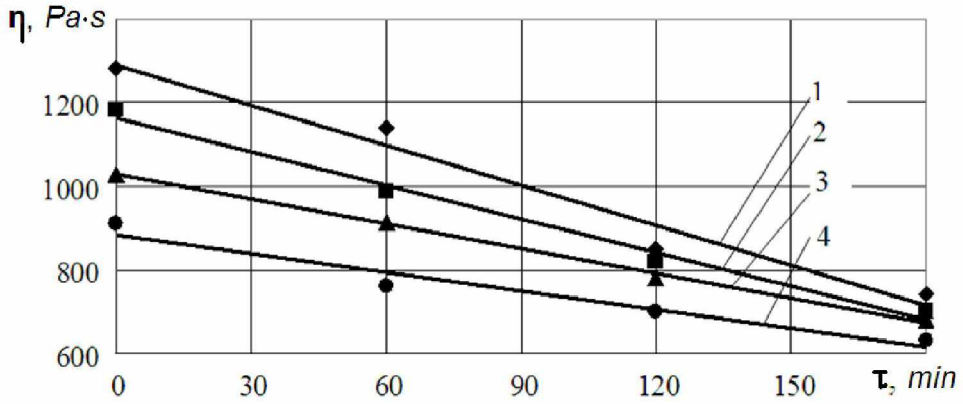

Fig. 3. Dependence of the effective viscosity of the dough from the time of fermentation when the specific work is:
1 - 7.5; 2 - 15; 3 - 22.5 ; 4 - 30 *J/g.*

The saturation of the dough by the oxygen dioxide at the expense of the fermentation leads to the reduction of the viscosity of dough, increase of the average speed of the flow and consumable characteristics (Fig. 4). The molding is possible in the zone of the lowest parameters of the pressure 0,2-0,4 MPa, security of the enough consumable characteristics of the process without defects on the surface of the extrudate.

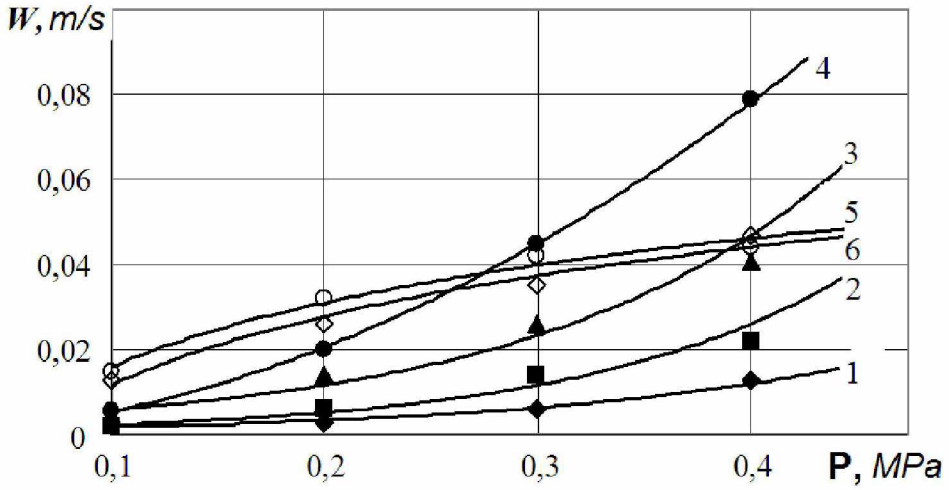

Fig.4. Dependence of the average speed of the extrusion of the dough cord of pressure with the content of gas phase, %:
1 – 0; 2 – 8,6; 3 – 23; 4 – 36; 5 – 42; 6 – 46

Average flow seep increases with the increase of the content of gas phase. The amount of gas more than 40% (graphs 5,6) and gradient of pressure 0,3-0,4 MPa lead to the destruction of the gas bubbles, pressure inside of them exceeds the power of the surface tension and the border of the firmness of their sides. The state of the surface of the dough cord decreases. Defects connected with the irregularity of the flow appear, as well as gaps of the solid surface layer of the dough and the loss of the kinetic energy of the flow. It is witnessed by the character of the graphs.

With the smaller values of the pressure 0,1-0,25 MPa the surface layer doesn't destroy, but a larger porosity of the ready item in the result of the pores' merge is observed, as well as gaps inside the dough cord is observed. Equation of the dependence of the average speed

of the flow w from the pressure of extrusion P,MPa with different content of the gas phase G, % for the constant mode, when the irregularity of the flows are not observed (graphs 1-4) has the look of:

$$w = 0{,}045e^{0{,}06G}\mathrm{P}^{(-0{,}1G+1{,}9)}$$

In the flow of the non-Newton liquid at the exit of the formation channel pressures normal to the surface of the shift appear and continue to run. The phenomenon of the swelling of the flow didn't have value with the usage of the extrusion process for the traditional molding of the dough blanks, as after molding, cord is being processed additionally.

The usage of the extrusion gas filled dough without the subsequent stages of the processing before the baking need a comprehensive study of the very process. It is necessary to determine the influence of the geometry parameters of the molding channel on the size, condition of the surface and the character of the porosity of the dough cord and the made items.

For the quantitate evaluation of the diameter increase of the dough cord in the comparison with the diameter of the molding channel we used the coefficient of the expansion, which takes into account non-Newton character of the flow and increase of the size of the extrudate in the result of the allocation of the gas phase. The coefficient of the expansion was defined as a ratio of the cord diameter to the diameter of the molding channel.

The research showed that with the increase of the length of the molding channel the value of the coefficient of the expansion decreases in the result of the structural changes of the components of the extrudate, which strengthen its carcass, orient the molecules along the flow, which decreases the coefficient of the expansion. In the long channel the energy of the flow is being lost as a result of the friction and increase of the shift deformation in the surface zone of the extrudate. The fall of the pressure in such channel runs slowly, gradient of the change of pressure in the bubbles isn't significant and such slow allocation of gas leads not to the formation of the new centers of its formation, but to the growth of the existing bubbles of gas and formation of the coarse-pored structure of the extrudate.

With the increase of the length of the channel the energy losses on the viscosity friction and elastic flow deformation increase, in the result of which the kinetic energy of the flow decreases (Fig.5).

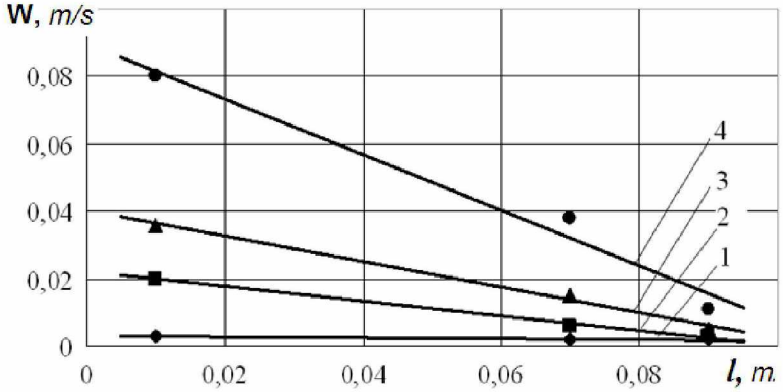

Fig.5. Dependence of the average speed of the extrusion from the length of the channel with the pressure, MPa:
1 – 0,1; 2 – 0,2; 3 – 0,3; 4 – 0,4.

For the study of the dependence of the coefficient of the expansion from the angle of the entrance in the molding channel and content of the oxygen dioxide in dough, matrix with the different entrance angle were used.

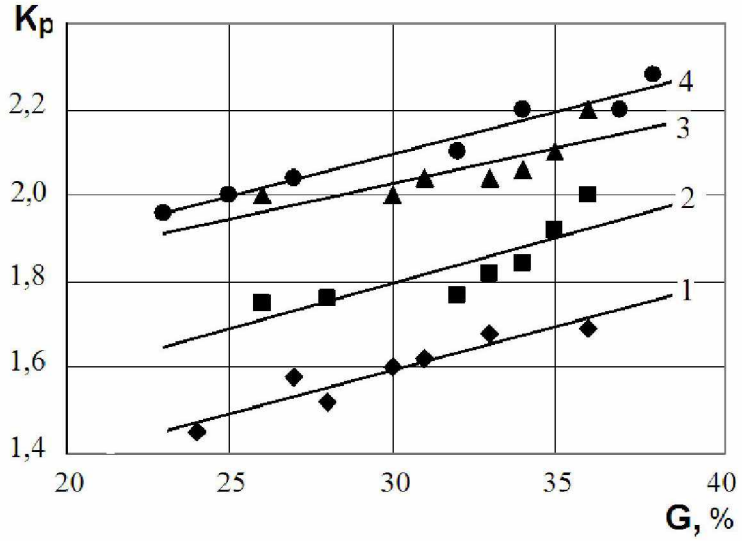

Fig.6. Dependence of the coefficient of the expansion from the content of the gas phase in the dough with the value of the angel of the entrance in the molding channel:
1 –20°; 2 –35°; 3 - 90°; 4 –65°.

The study showed (Fig.6), that the graph of the dependence of the coefficient of the cord dough expansion from the angel of the entrance in the molding channel has the extreme. The optimal value of the taper entrance - 70-80°. We agree that it is connected with the time of the dough passage in the channel, which is enough for the restruction of the high-molecular connection. These connections determine the structure of the dough, reduction of the voltage at the entrance in the channel and change of the molecules' orientation.

At the values of the entrance angle in the channel higher than 80°, the zone of the entrance into the channel is short. The time of the dough staying in this specific zone is shorter than the duration of the relaxation of the pressures, which appear with the constriction of the flow. Execution of the entrance into the channel under the direct angle is considered to be unnecessary in the result of the increase of the pressures and energy loss of the flow, which lead to the decrease of the diameter of the cord at the exit. With the decrease of the angle of the entrance, the overall length of the channel increases and the flow energy loses.

Conclusion

On the basis of the research of mixing and extruding processes of the gas-filled dough we propose the design of mixing-fermentation-forming unit, which allows to combine the processes of continuous intensive dough mixing, aerated dough pieces fermentation and formation directly to the baking plate.

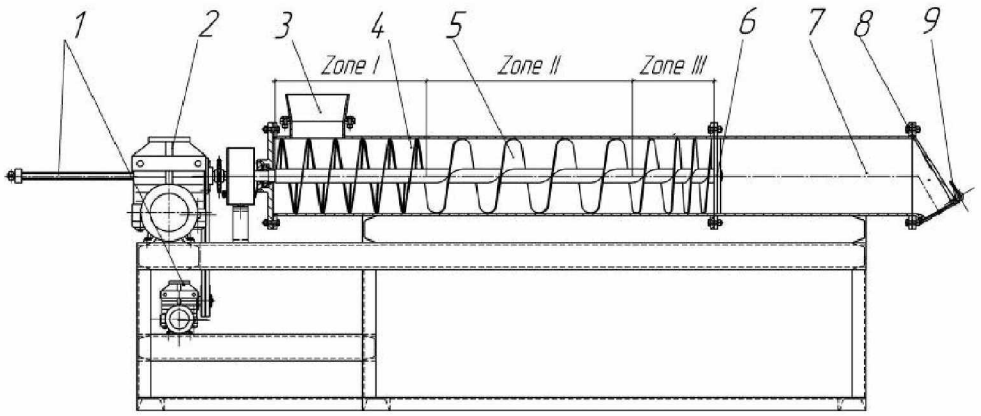

Fig. 7. Mixing-fermentation-forming unit:
1 – driver, 2 - reception funnel, 3 - mixing chamber , 4 - working body, 5 - mechanism of regulation of the intensity of mixing, 6 - fermentation chamber, 7- forming matrix, 8 - gate, 9 - mechanism of discharge.

There are screw tools installed in the mixing zone, which desing foresees the provision of three-phase mixing of dough, namely: mixing of the components is done with the spiral tool (zone I), mixing occurs with the minimal use of energy due to use of screw with the large pitch (zone II) and at the stage of dough plastification – the intensive mechanical processing by the screw tools with variable pitch (zone III).

Use of the screw with the decreasing pitch at the final stage of mixing provides the necessary pressure for feeding into the fermentation chamber

Thereby the carried out research allowed to determine the influence of the geometry of the molding channel and the content of the gas phase to the character and structure of the porosity of extrudate at the molding of the gas filled dough.

The results should be used in the design of new and reconstruction of existing production lines of bakery products.

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