THE STUDY OF CORRELATION BETWEEN TECHNICAL PARAMETERS OF THE MIXER AND THE QUALITY INDICES OF DOUGH

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Abstract: *Kneading operation aims to achieve a homogeneous mixture of raw and auxiliary materials and at the same time obtain dough with specific structure and properties. Dough formation arises due to physical and colloidal processes, factors which have a big influence on energy consumption. Due to present situation in energetic sphere, it has been decided to make a study and determine the optimal properties and conditions of dough kneading process. Using a laboratory mixer, approached to an industrial one, and different measuring instruments, it has been modeled, studied and determined the optimal kneading parameters, namely the dependence of energy consumption on working tool speed. There were obtained curves of specific energy consumption dependence during kneading process for different working body speeds. The result of the study show that the increase of the working speed from about 200 up to 400 min^{-1} does not cause a significant increase in energy consumption, and even, in some cases it decreases, while further speed increasing causes a significant increase of power.*

Keywords: technical parameters of the mixer, quality indices of dough, energy consumption.

I. Introduction

Qualitative dough mixture assumes an attaining of a homogeneous structure and properties of specific viscosity and elasticity.

Dough formation arises due to physical and colloidal processes:

- physical processes are related to mechanical action during dough kneading and temperature rising;
- colloidal processes are related to the formation of gluten and dough colloidal structure, components hydration and proteins deflocculating process.

Therefore there was a close correlation between physical and colloidal processes in order to obtain qualitative dough.

Knowing the gluten content and its role in dough shaping, it was supposed the existence of a link between colloidal processes and kneading intensity, which determine energy consumption and final product quality [1].

Rheological properties of the dough have an important contribution on the quality of bakery and pastry products. The final quality of the products mentioned above depends not only on the quality of raw materials, but also on following all stages of the technological process. Knowing the rheological parameters of bakery flour and rheological parameters of the dough, particularly helps people who work in this area, in order to appreciate technological and functional parameters of the equipment which processes this dough and allow them to optimize the baking process.

II. Materials and methods

Dough kneading process was performed with a "ZELMER" discontinuous mixer with two vertical blades and shaft furniture. The blades are spiral shaped, this fact presenting its area of work – dough kneading.

Mixer's bowl has a capacity of 3 liters. Also this mixer allows choice of 4 speeds: 192; 290; 385 and 480 min^{-1}, with a nominal power equal to 160 W, and maximal power 400 W.

The mixer was equipped with an ammeter (measurement accuracy ± 0,025 A), a voltmeter (measuring precision ± 5 V) and a voltage regulator to provide needed voltage in limits of input voltage. Electricity intensity and voltage, during kneading process, were registered at intervals of 1 minute.

For weighing raw materials was used an electronically scale with maximal capacity of 300 g.

The research has been made in „Agro-alimentary" scientific laboratory, Technical University of Moldova, provided with all the necessary equipment.

For the study was used high quality wheat flour containing 25% and 27% gluten and 14% humidity. For one portion of dough kneading were used 200±10 g flour, 3±0,15 g salt, 6±0,15 g yeast and 110±0,5 ml water.

Amount of gluten in the flour content was determined by the "hand washing gluten flour" method according to [STAS 90-77], [GOST 27839-88].

III. Results and discussions

After processing the experimental data, there were obtained curves of specific energy consumption dependence during kneading process for different working speeds body (Figure 1(a) and 1(b)).

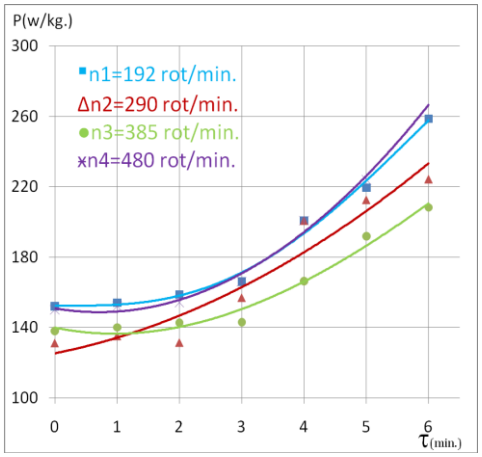

Figure 1(a) *Dependence of energy consumption by time for different speed of the working blade for dough with 25% gluten content*

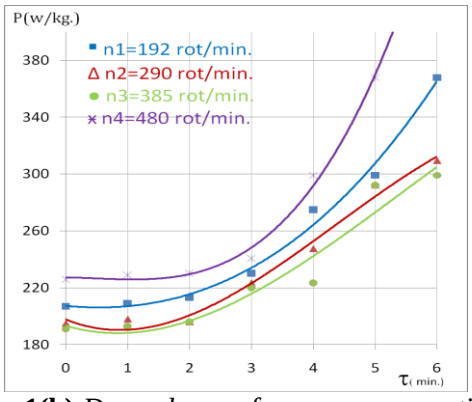

Figure 1(b) *Dependence of energy consumption by time for different speed of the working blade for dough with 27% gluten content*

From obtained graphs is observed that regardless of flours gluten content, once increasing process duration, energy consumption increases. This is due to changes in time of dough properties, and hence increased resistance to blades movement through product.

Mathematical description of the correlation between kneading duration and energy consumption is shown in (Table 1).

Table 1. *Correlation between kneading duration and energy consumption*

Working tool speed, min^{-1}	Equation
25% gluten	
192	$P = 14{,}609\tau^2 - 55{,}172\,\tau + 280{,}33$
290	$P = 5{,}8929\tau^2 - 9{,}3304x + 208{,}31$
385	$P = 29{,}562\tau + 135{,}44$
480	$P = 2{,}2098\tau^2 + 10{,}165x + 165{,}69$
27% gluten	
192	$P=-0{,}099\tau^4+1{,}1701x^3-0{,}5399x^2+0{,}0501x+152{,}39$
290	$P=1{,}8229\tau^2+7{,}0729x+125{,}32$
385	$P=-0{,}1447\tau^3+4{,}06x^2-7{,}3667x+139{,}9$
480	$P=4{,}2188\tau^2-6{,}0164x+150{,}85$

In first 2 minutes it was observed a relative stability of energy consumption, which presents that in this period the process is limited only at mixing raw materials, without essential colloidal changes.

Next, till the end of the process (sixth minute) because of the physical impact of the working tool – blade and the colloidal processes, the dough changes its viscosity and elasticity properties, causing an increased resistance of the working body tool movement, therefore a growth of energy consumption. In the mixing process, after particle got wet, the mechanical action helps them join in a mass, forming dough. If mixing of the formed dough continues, this step-by-step improves its rheological properties.

Both, rapid and slow mixing leads to a quality formed dough, but the energy consumption itself is distinct for different working tool speeds. These can be observed from curves.

Graphs in Figure 2(a) and 2(b) show the energy consumption change depending working body speed, at different periods of kneading process.

Graphs also show that the increase of the working speed from about 200 up to 400 min^{-1} does not cause a significant increase in energy consumption, and even, in some cases it decreases, while further speed increasing causes a significant increase of power.

So, it can be concluded that in order to increase the quality of dough`s sensorial properties, it is recommended a variation of working tool speed only up to 400 min^{-1}.

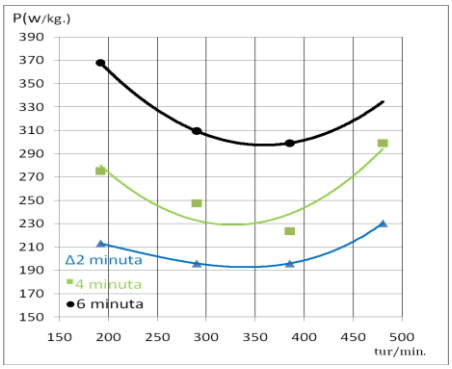

Figure 2(a) *Influence of working tool speeds on energy consumption for different periods of kneading process at 25% gluten content*

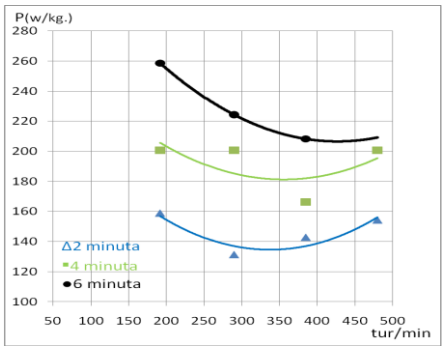

Figure 2(b) *Influence of working tool speeds on energy consumption for different periods of kneading process at 27% gluten content*

IV. Conclusions

The research showed the following results. During the homogenization of the mixture of flour, water and auxiliary products, energy consumption is minimal and relatively constant. Further, during kneading process, once the dough viscosity and elasticity change, energy consumption increases. This phenomenon is suitable for all studied working tool speeds.

Increase of the working speed from 200 to 400 min^{-1} does not cause changes in energy consumption, while further speed increasing is accompanied with increased energy consumption.

The use of high and low speed of working body tool in mixing process of preparation of the dough usually has the same aim and result as that of obtaining simply the dough, but in order to optimize the parameters which refer to energy consumption during mixing is needed to utilize necessary speed in accordance with dough viscosity and elasticity, namely the humidity that it contains.

References

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