# INFLUENCE OF DOUGH MIXERS PALLETE TURATION ON ENERGY CONSUMPTION

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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, we 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, we 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 speeds body. They 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.*

**Key words:** Dough, gluten, kneading process, 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 quality 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].

## II. Materials and methods

For the study we used high quality wheat flour containing 25% and 27% gluten and 18% 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.

Mass of the flour, yeast and salt was weighed with electronic balance (accurate to ± 0.0002 g), the volume of water – with graduated flask (measurement accuracy ± 0.1 ml.).

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

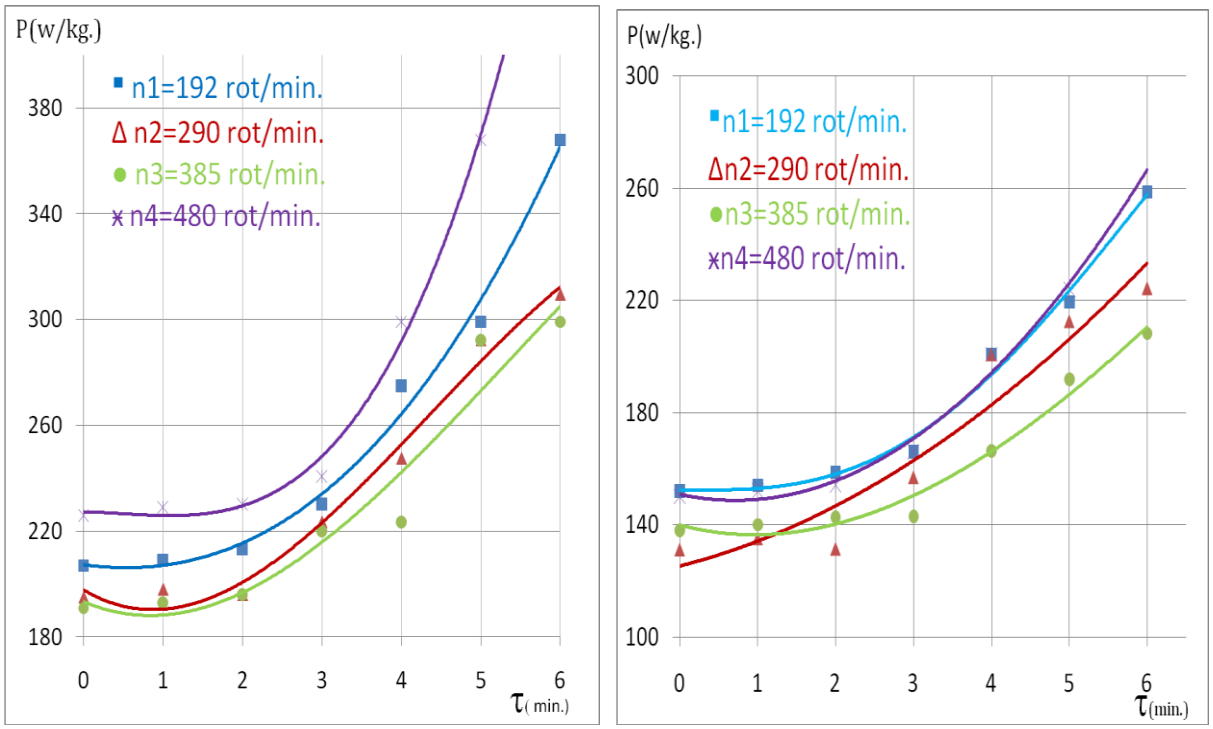
Dough kneading process was performed with a "ZELMER" discontinuous mixer with two vertical blades and shaft furniture. It was equipped with an ammeter (measurement accuracy ± 0.025 A) and a voltmeter (measuring accuracy ± 5 V).

Electricity intensity and voltage, during kneading process, were registered at intervals of 1 minute. The mixer allows choice of 4 speeds: 192, 290, 385 and 480 r/min.

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

## 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 (Fig. 1.a., 1.b.). 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.




a) b)

**Figure 1.** *Dependence of kneading period on blade speed: a) 25% gluten; b) 27% gluten*

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

| Working tool speed, $min^{-1}$ | Equation | R-squared value |
|---|---|---|
| 25% gluten | | |
| 192 | $P = 14{,}609\tau^2 - 55{,}172\,\tau + 280{,}33$ | $R^2 = 0{,}994$ |
| 290 | $P = 5{,}8929\tau^2 - 9{,}3304x + 208{,}31$ | $R^2 = 0{,}9858$ |
| 385 | $P = 29{,}562\tau + 135{,}44$ | $R^2 = 0{,}9851$ |
| 480 | $P = 2{,}2098\tau^2 + 10{,}165x + 165{,}69$ | $R^2 = 0{,}9052$ |
| 27% gluten | | |
| 192 | $P=-0{,}099\tau^4+1{,}1701x^3-0{,}5399x^2+0{,}0501x+152{,}39$ | $R^2 = 0{,}99$ |
| 290 | $P=1{,}8229\tau^2+7{,}0729x+125{,}32$ | $R^2 = 0{,}9256$ |
| 385 | $P=-0.1447\tau^3+4{,}06x^2-7{,}3667x+139{,}9$ | $R^2 = 0{,}977$ |
| 480 | $P=4.2188\tau^2-6{,}0164x+150{,}85$ | $R^2 = 0{,}9829$ |

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

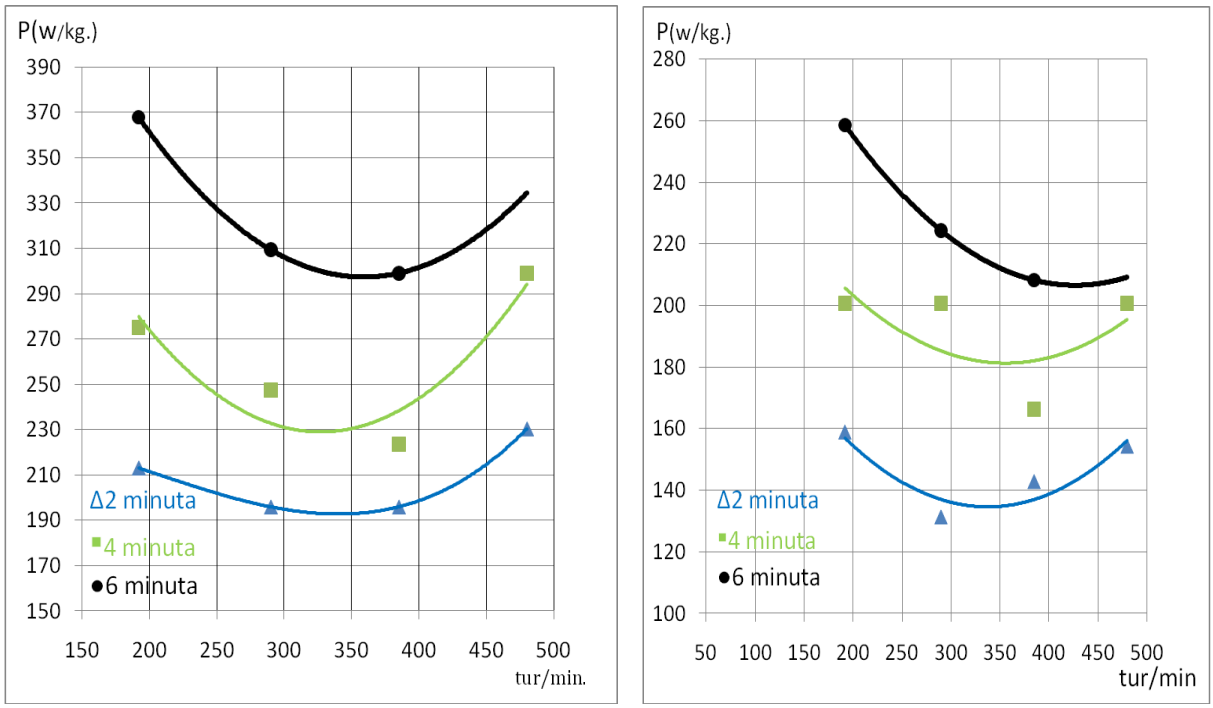
In the first two minutes we see relative stability in energy consumption which indicates that during this period the process is limited to mixing with no essential colloidal changes. Further, by the end of the process ($6^{th}$ minute), due to physical impact blade and

colloidal processes, dough changes its viscosity and elasticity properties, causing an increased resistance of working body movement.

Graphs in figure 2 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, we can conclude that in order to increase the quality of dough`s organoleptic properties, it is recommended a variation working tool speed only up to 400 $min^{-1}$.




a) b)

**Figure 2.** *Influence of working tool speeds on energy consumption for different periods of kneading process: a) 25% gluten; b) 27% gluten*

## 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.

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