

PROCESS RESEARCH OF GRIND ENRICHED GROATS PRODUCTS IN THE ROLLER MACHINE OF THE 2ND GRINDING SYSTEM OF MILLING OF HIGH-GRADE FLOUR

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The modes of grinding are determined and the mathematical dependences of the product of flour and grain products of the first grinding system with additional equipment entoleiter-dismember ESM-1,5 are offered. The largest product of flour on the 2nd grinding system is achieved by grinding modes on a roller machine – 35 %. The use of entoleiter-dismember ECM-1.5 allows to increase the total product of flour on the 2nd grinding system to 62 %.

Key words: *wheat, modes, grinding, flour, systems, roller machine, dismember enthlators.*

Introduction. In accordance with the adopted structure of varietal grinding of wheat, the first three grinding systems grind products of the first quality. On these systems, the largest amount of flour of high grades is formed, so the study of grinding modes of these systems is of great importance for obtaining the largest yield of flour of the highest grade. The mode of operation of grinding systems is determined by the production of flour of the highest grade. Studies of grinding modes in the drag process have established that there are modes of grinding grain and stair products of the drag process in roller machines in which the largest yield of grain-based products is achieved, which are subsequently sent for enrichment. The largest yield of cereal products, which can be obtained in the drag process, makes it possible to increase the yield of flour of high grades, which are obtained on the first three grinding systems. Enriched grains and duns are fed to grinding systems, where they are crushed to particle sizes less than 130 microns, forming flour of the highest quality. Therefore, there is a question of the effectiveness of grinding modes of enriched grain-and-stone products in roller grinding machines in order to obtain the largest yield of flour [1, 2].

Ukrainian company OLIS LLC has started mass production of ESM-brand dimmeders, which are structurally different from typical P3-BER entholers, so the use of new ESM-1.5 dismembrators enthusiasts is promising since they have a greater technological efficiency of grinding first quality products into flour. The cereal products obtained in the drag process go through the enrichment process and are fed into the grinding process for maximum grinding into flour. The grinding stage structure

is simpler than the drag stage [3].

With the introduction of BUHLER grinding technologies after roller machines, P3-BER and A1-DBG decathora are used for additional grinding and destruction of particle conglomerates. P3-BER entomers are used mainly on the first three grinding systems that process grinding products of the first quality with low zolity. Many researchers [4, 5] were involved in the research of grain grinding in roller machines. On these grinding systems get the largest amount of flour of high grades. P3-BER entomers are a type of machines of the so-called disintegrator type, and decathers are machines of shock-erasing action. Studies of domestic and foreign researchers confirmed the feasibility of additional grinding of intermediate grinding products at flour mills of varietal wheat grinding. The grinding process is less studied, since the results of its work have less impact on the quality indicators of flour output than the drag process. In production conditions, the grinding process is also paid less attention than the drag process.

The company OLIS has developed entomers-dismembrators ESM-1,5 [3], which are cut off from P3-BER entholers by the intensity of action on the crushed product. Similar dismembrators are manufactured by the Dutch company OTTEVANGER. Dismembrators are promising for use in the flour industry due to more intensive action on intermediate grain grinding products than typical P3-BER entroners.

The first studies of technological efficiency of the work of dismembrators enthusiasts belong to O. P. Vereshchinsky [3]. In his works there is a linear empirical dependence of the flour output of the first and second quality, depending on the speed of rotation of the working body and the extraction of flour in the roller machine. The analysis of empirical equations states that with an increase in the total production of flour in the roller machine, the output of flour in the enteroetor-dismembratory increases, but the nature of this dependence is not given and remains unclear for which grinding systems empirical dependences can be applied.

Based on this, it is advisable to investigate the effect of grinding modes of the roller machine – entoleiator-dismembrator system. In literary and information sources there is no data on the modes of grinding roller machines of the most important first three grinding systems of the first quality on which the largest amount of flour of high grades is obtained [6, 7]. These issues are important for designers when ploughing the balance sheets of new mill mills, as well as for technologists of flour mills. [8, 9]. Based on this, one of the tasks of our scientific research is to study the modes of grinding groats products in roller machines and dismembrators, as well as their joint action.

The consumption of electricity for grinding is one of the important indicators of grain processing into flour, no less important than the output and quality of finished products. In conditions of high cost of energy, electricity consumption for grinding in general is of an important economic nature. On the basis of electricity consumption, the technological indicator is based – the cleezm [10]. Determining the cost of electricity for grinding grain, take into account the whole range of characteristics of its structural and mechanical properties. The amount of work of grinding grain within each crop depends on strength, hardness, plastic properties of grain, as well as preparatory operations [11].

Of the total energy consumption at the mill plant 70... 75% is spent in the grinding process and about 11 % in the grain cleaning department. The grinding process consumes at least 1/3 of the total amount of energy consumed [12]. In the grinding process of the mill plant 55... 58 % of energy is spent in the drag process, 25... 57 in sieve and grinding processes and 42... 46 % – in the grinding process. Specific energy consumption is closely correlated with the actual output of flour. The cost of electricity for the production of flour depends on the degree of development of the grinding technological scheme. With a more developed technological scheme, electricity consumption is higher. Recommended norms of specific electricity consumption in multisorted cuts with a developed scheme of pomelo are 65... 70 kWh per 1 ton of flour produced, for grinding with a reduced technological process scheme are 52...60 kWh per 1 ton of flour produced. When implementing new technologies of generation and technological solutions, it is necessary to ensure that the specific electricity consumption does not exceed the recommended standards [13, 14]. Therefore, reducing the cost of electricity for grinding grain and intermediate products is an important engineering task.

Research methodology. During the research, wheat grain was processed with the following quality indicators: total grain weight – 791 g/l, grain moisture on the I drachma system – 16.2 %, glassiness – 38 %, garbage admixture – 0.4 %, grain admixture – 2.3 %.

The study of indicators of grain quality and milling products was carried out in the production laboratory in the production conditions of the flour milling plant with a capacity of 330 tons per day. To study the system «roller machine – entoleiator-dismembrator» was chosen the first three grinding systems of the first quality, on which install dismembrators for maximum grinding of enriched products into flour.

The change of grinding and sampling modes on the first grinding system was carried out as follows: during the operation of the grinding department on the specified system along the entire length of the roller, the product in the amount of up to 400... 500 g. Since grinding products are fed by pneumatic transport from the roller machine to the dismembrators, and then to the cyclone-unloader, the sampling under different grinding modes was carried out through the hatches after the cyclone-unloader. After selecting the product with the help of the helm, which is equipped with roller machines, the gap between the rollers was changed and the product was re-selected along the entire length of the roller and after the enteroetor-dismembrator.

Grinding products were sifted on a set of sieves No. 27PA-120, No. 33/36PA, No. 41/43PA and No. 49/52PA. The obtained results of the output of individual fractions of grinding products were graphically depicted in the coordinates of the «total product of flour – the output of the fraction». On the first three grinding systems microcosm rollers are installed. The rotational speed of the rotors of dismembrator entomers was 50c-1 (3000 rpm) and did not change during the research.

Results of research. It is proved that on the 1st grinding system, the roller machine can produce higher grade flour up to 28 %, the use of ESM dismembrators increases the product of higher grade flour to 56 %. The linear dependence between flour production in the roller machine and ESM-1.5 entoleitori-dismembratory was

experimentally established. Therefore, it would be interesting to investigate the influence of ESM-1.5 dismembrators on increasing the production of higher grade flour and in roller machines of the 2nd grinding system.

The main product of grinding for the 2nd grinding system are stair products that are sent from the 1st grinding system. Depending on the mode of operation of the 1st grinding system – this is a mixture of small grains and duns. It is possible the presence of flour in the stair products that enter the roller machine of the 2nd grinding system due to under-sowing. After grinding, the mixture consists of small grains, dunts and flour. Studies carried out in production conditions have found that with a decrease in the gap between the roller rollers of the roller machine when grinding stairs from the 1st grinding system on the 2nd grinding system, there is a decrease in the yield of small grains and dunstites, and the yield of flour of the 1st grade increases by a small amount. The results of research are given in Figure 1.

With an increase in the total production of higher grade flour in the roller machine from 5.3 % to 35.8 % the yield of small grains decreased by 9.9 % from 11.9 % to 2.0 % by curvilinear dependence, the output of dunstites decreased by 22.3 % from 53.9 % to 31.6 % by curvilinear dependence. The yield of flour of the highest grade increased by 2.7 % from 9.5 % to 12.2 %. Comparison of the obtained data indicates that the contents of the Duns in the crushed mixture has a significant content and the formation of higher grade flour occurs due to the grinding of mainly dunts and less small grains. The increase in flour of the first grade is insignificant compared to the output of the highest grade flour.

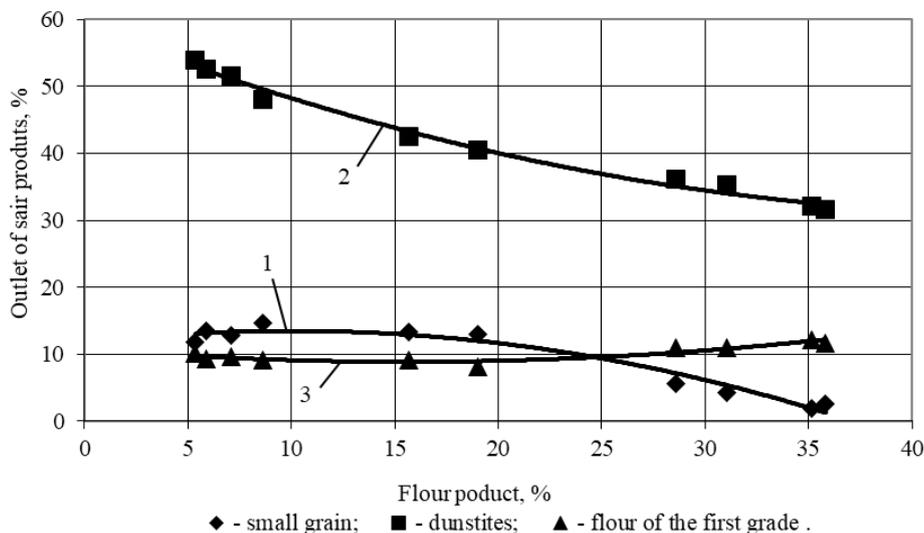


Fig. 1. Outlet of stair products after grinding in the roller machine of the 2nd grinding system, taking into account the under-sowing

Crushed product after rollers with pneumatic transport is fed to the entoleiator-dismembrant ESM-1,5, in which additional grinding of small grains and dunstites is carried out. With an increase in the total product of higher grade flour in the roller machine after passing a mixture of grinding products through the entoleiator-dismembrator ESM-1.5 there is a similar decrease in the yield of small grains and dunts also in curvilinear dependences, and the yield of flour of the first grade does not

change significantly. The results of research are given in Figure 2.

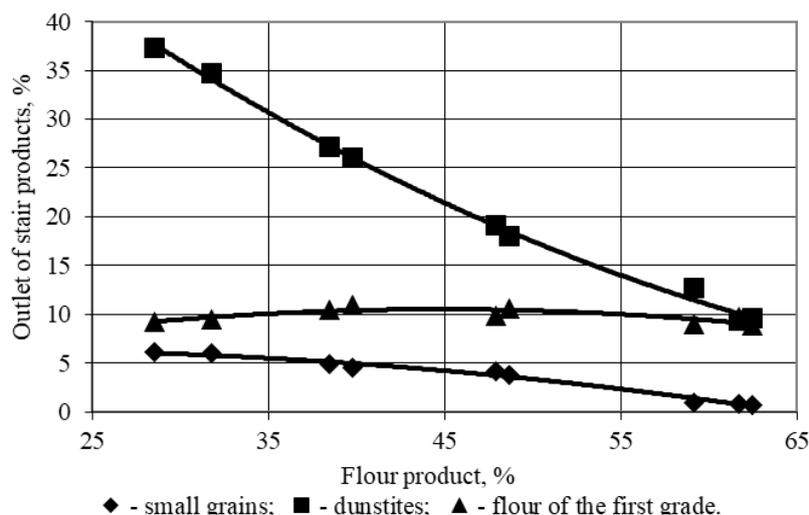


Fig. 2. Outlet of stair products on 2 grinding system (roller machine + entoleitor-dismembrator) taking into account under-sowing

The increase in the total production of higher grade flour from 28.5 % to 61.7 % on the 2nd grinding system led to a decrease in the yield of small grains by 5.2 % from 6.0 % to 0.8 %, dunst by 27.9 % from 37.3 % to 9.4 %. The output of flour of the first grade did not increase significantly and ranged from 9.0 % to 11.0 %.

From the analysis of Figure 1 and 2 also show that the roller machine of the 2nd grinding system can give a maximum flour production of up to 35 %, at the same time, additional grinding of intermediate products in the enteroetor-dismembratory allows you to increase the total product of higher grade flour to 60 %, which is 25 % more than when using only one roller machine.

The output of grinding products on the 2nd grinding system, depending on the total product of flour of the highest grade $Vb.v.s.$, is described by the following equations:

output of small grains on the 2nd grinding system:

$$Kr = - 0.00291 V2b.v.s. + 0,104 Vb.v.s. + 5,4$$

where Kr , second time – output of small grains, %;

$Vb.v.s.$ – the total product of higher grade flour on the 2nd grinding system, %.

The research data correlation coefficient is 0.98, the standard deviation is 0.33%.

Output dunst on the 2nd grinding system:

$$Vd = - 0.00918 V2b.v.s. - 1,659 Vb.v.s. + 77,52$$

where, VD – output of duns, %;

$Vb.v.s.$ – general product of flour of the highest grade on the 2nd grinding system, %.

The correlation coefficient is 0.99 and the standard deviation is 0.58 %.

Output of flour of the 1st grade on the 2nd grinding system:

$$B1c = - 0.004807 V2b.v.s. + 0,429 Vb.v.s. + 0,88$$

where, $B1c$ – yield of flour of the 1st grade, %;

$Vb.v.s.$ – general product of flour of the highest grade on the 2nd grinding

system, %. The correlation coefficient is 0.81 and the standard deviation is 0.42 %. Roller machine and entoleiator-dismembrator ESM-1,5 2nd grinding system work as one system, so it is advisable to investigate the effect of grinding intermediate products in the roller machine for the product of flour in the enteroetor-dimmbrator.

Studies have found that the dependence of flour yield in the ESM-1.5 enteroleitori-dismembrateor obeys the linear law depending on the production of higher grade flour in the roller machine of the 2nd grinding system (Figure 3).

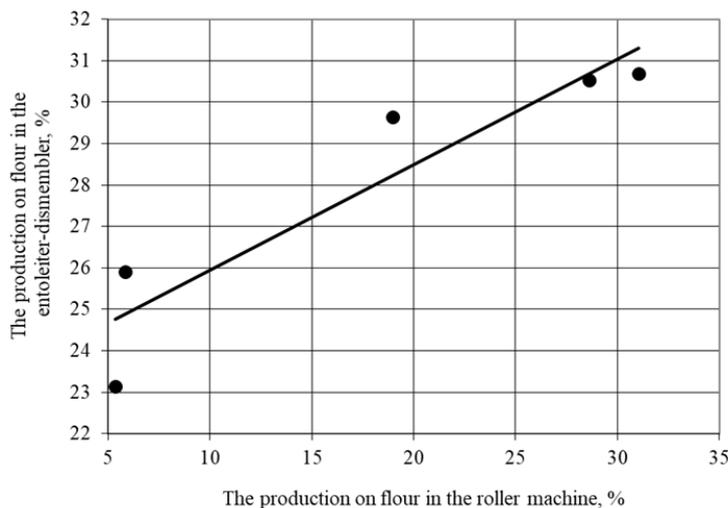


Fig. 3. Dependence of the yield of flour of the highest grade in the enteroetor-dismembratory on the production of flour in the roller machine of the 2nd grinding system, taking into account the under-sowing

With an increase in the production of flour of the highest grade in the roller machine from 5.3 % to 31.0 %, the yield of flour after enteroetor-dismembrator ESM-1.5 increases in accordance with 23.1 % to 30.6 %. The correlation coefficient of the research data is 0.92, which indicates a close relationship of the studied features.

This dependence can be explained by the fact that the roller machine of the 2nd grinding system grinding intermediate products that are fed to it creates microcracks in grains and dunes, violates the microstructure of particles, reducing their strength, which then collapse to smaller particles along the boundaries of the formed cracks when passing through the entoleiter-dismemberator ESM-1.5 To ensure the largest yield of flour of high grades, we can recommend the lowest grinding modes in the roller machine. During production studies, it was not possible to achieve the conditions under which the grinding process will be accompanied by the formation of flakes.

The optimal value of the total flour production on the 2nd grinding system could not be established, based on the conditions of actual production, we can recommend the grinding mode in the roller machine of the 2nd grinding system, in which flour production is achieved up to 30.0 %.

Studies have found that on the 2nd grinding system, the roller machine can produce higher grade flour up to 35 0%, and the use of ESM-1.5 dismembrators increases the product of higher grade flour to 62.0 %.

Conclusions. The grinding modes were determined and mathematical

dependences on the product of flour and grain-bearing products of the first grinding system with additional equipment with entoleiator-dismembrator ESM-1,5 were proposed. The largest production of flour on the 2nd grinding system is achieved under the grinding modes on the roller machine – 35 %. At the same time, the use of enteroeithor-dismembrator ESM-1.5 allows increasing the total flour production on the 2nd grinding system to 62 %. It was experimentally established that the dependence between the production of higher grade flour in the roller grinding machine and the release of higher grade flour in the ESM-1.5 enteroleitori-dismembratory has a linear dependence. The results of experimental studies are described by mathematical dependences, which allows using them to calculate the quantitative balances of flour.

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Annotation

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Process research of grind enriched groats products in the roller machine of the 2nd grinding system of milling of high-grade flour

Introduction. Studies of the grinding modes in the shredded process have established that there are modes of grinding grain and similar product of the shredded process in roller machines which achieve the highest yield of grain products, which are then sent for enrichment. The highest yield of grain products that can be obtained in the shredding process makes it possible to increase the yield of high-grade flour, which is obtained on the first three grinding systems. There are no data in the literature and information sources on the modes of grinding of roller machines of the most important first three grinding systems of the first quality on which the largest amount of high-grade flour is obtained. These issues are important for designers when developing the grinding balances of new flour mills, as well as for flour mill technologists. Based on this, one of the tasks of our research is to study the modes of grinding of grain products in roller machines and entoleiters-dismembers, as well as their combined action.

Aim. Increasing the competitiveness of products of domestic flour mills by improving the technological process of grinding wheat grain into flour and reducing energy consumption in the process of its production.

Methods. Studies of wheat grain quality and grinding products were carried out in the production laboratory in the production conditions of the flour mill with a capacity of 330 t/day. To study the system "roller machine - entoleiter-dismember" the first three grinding systems of the first quality were chosen, on which entoleiters-dismembers are installed for maximum grinding of enriched products into flour.

Results. The modes of grinding are determined and the mathematical dependences of the product of flour and grain products of the first grinding system with additional equipment entoleiter-dismember ESM-1,5 are offered. The largest product of flour on the 2nd grinding system is achieved by grinding modes on a roller machine – 35 %. The use of entoleiter-dismember ECM-1.5 allows to increase the total product of flour on the 2nd grinding system to 62 %.

Conclusions. The modes of grinding of intermediate products of first-grade grinding in the rollers and ESM-1,5 dismember enthlators are investigated. On the basis of experimental data, the dependences of the output of certain classes of intermediate products of grinding from the products of the studied systems are obtained.

Key words: wheat, modes, grinding, flour, systems, roller machine, dismember enthlators.