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CONSIDERATIONS REGARDING THE OPTIMIZATION OF THE MECHANICAL CONDITIONING PROCESS OF GRAIN INTO THE INDENTED CYLINDER SEPARATORS

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Abstract: The optimal functioning of the indented cylinder separators can be defined and approached from several points of view. The optimal functioning, in general, means the functioning in a working regime characterized by a combination of parameters that produce the minimization or maximization of an operating parameter which acts as a measure of the working process quality. This paper approaches both aspects regarding the optimization of the geometrical-functional characteristics, and the optimization of the working process quality of the cylinder separators depending on its rotation speed.
Keywords: grain conditioning, indented cylinder separator, optimizing process

1. CONSIDERATIONS REGARDING THE OPTIMAL FUNCTIONING OF THE INDENTED CYLINDER SEPARATORS

The optimal functioning of the indented cylinder separators can be defined and approached from various points of view. The optimal functioning, generally, it means functioning in a working regime characterized by a combination of parameters that produce minimization or maximization of a characteristic indicator that acts as a measure of quality of work. The optimal functioning has a strict sense (literally) if the extrem point is inside the interval and improper sense if it is located on the border area of working parameters.

The quality indicators of the conditioning process into the indented cylinder separator are:

- ✓ the content of small foreign bodies at the outlet of the cylinder separator C_{sme} [%];
- ✓ the technological effect of the cylinder $E_{csm}=[(C_{smi}- C_{sme})/C_{smi}]x100$ [%];
- ✓ the percentage of good grains lost in subproducts $C_{ps} = \left(\sum mk / M\right) x100\ [\%],$

where: C_{smi} is the content of small foreign bodies at the intlet of the cylinder separator, in %; *mk* – the mass of good grains lost in subproducts, in *g*; *M* – the mass of good grains from the initial sample of raw material, in *g*.

The finding of possible optimal points in the functioning of the indented cylinder separator, depends on the set of parameters considered in computing, the range of their variation and, mainly the defining the objective function that has to be minimized or maximized, according to the physical sense. Thus, for the indented cylinder separator, objective functions can be:

- ✓ quality of the finished product expressed by the technological effect or the content of impurities in the finished product and overall quality of the separation process expressed by the first two and the percentage of good grains lost in subproducts, as well as their possible combinations that minimize / maximize simultaneously two of the quality characteristics above;

- ✓ overall quality of the process by which we mean the finished product quality relative to the energy consumptions, such an objective function being the energy consumption per unit of quality of finished product;
- ✓ consumptions in energy and power;
- ✓ working capacity.

The optimization of working process for machinery in general and for the indented cylinder separator in particular, can be approached both paths, the theoretical and the experimental, the possible combination of the two paths being made for the purposes of verification or development of theoretical-empirical models, eventually able to lead to optimal operating mode. There are some process parameters between wich there are not and it can not theoreticaly establish mathematical relationships. For these cases, the empirical study and theoretical-empirical study is required. It is the case of the percentage of good grain lost in subproducts, for which can not yet find a mathematical expression on purely theoretical way. You can find instead on empirical and theoretical-empirical way [4].

2. THE OPTIMIZATION OF GEOMETRIC-FUNCTIONAL CHARACTERISTICS

By geometric-functional characteristics we mean geometric parameters of the indented cylinder separator and adjusting parameters: the radius and the length of indented cylinder, the opening angle of the gutter, the alveoli sizes, surface density of alveoli, the flow of inlet, the rotation speed, the adjustment angle of the gutter [1].

It was found that it may be determined an optimal position for tilting the gutter, depending on the working regime and parameters that characterize the interaction between the processed material and the metal inner surface of indented cylinder and the alveoli. This optimal position is obtained by overlapping the bisector of the sector determined by calculation with the bisector of angle at center. The extreme points are situated on the indented cylinder and represent the minimum and maximum detachment points of impurities [4].

3. THE OPTIMIZATION OF THE QUALITY OF WORKING PROCESS DEPENDING ON ROTATION SPEED

The optimization of some quality parameters of working process for indented cylinder separator is performed with experimental data combined with the results of interpolation using the method of least squares. Experimental results were used because they contain information on energy consumption, the technological effect and the percentage of good grains lost in subproducts. If the first two indicators allows a theoretical expression, the third parameter, the percentage of good grains lost in subproducts, do not allow a satisfactory description, within the limits of the current theoretical models. Even in terms of energy consumption, the estimations purely theoretical are affected by errors of measurement precision and randomness of the process.

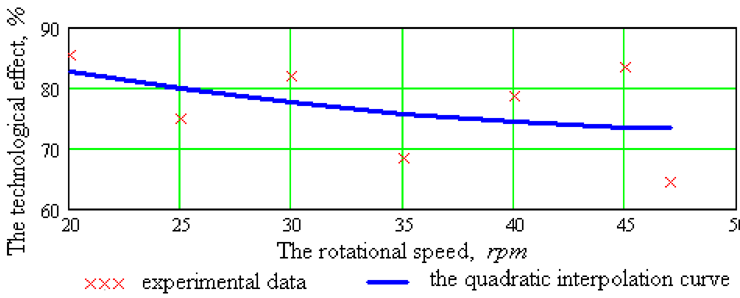

Fig. 1 - The variation of technological effect depending on the rotation speed of the indented cylinder

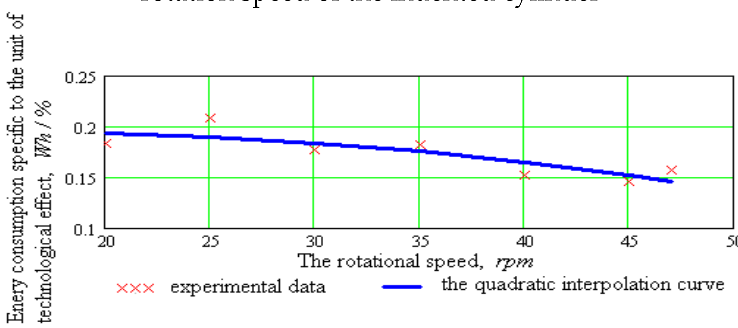

Fig. 2 - The variation of energy consumption specific to the unit of technological effect depending on the rotation speed of the indented cylinder separator

The Figure 1 represents graphically the variation of technological effect depending on the rotation speed of indented cylinder, with *x* being represented the experimental data and with continuous line, the second grade function that interpolates data, having the formula:

$$Ecsm(n) = 0.0099n^2 - 1.0134n + 99.061\,, \tag{1}$$

where *Ecsm* is the technological effect and *n* is the rotation speed in *rpm*. It is noted that the technological effect decreases with increasing rotation speed and within the limits of working intervals, the maximization (ie optimization) occurs in the far left (lower) range of rotation speed, respectively at the minimum considered rotation speed. This is a normal result, expected, that validates the results of experimental research.

Further, were searched the possible optimal points by minimizing the energy consumption per unit of quality, considered to be the technological effect. The variation of the ratio between the energy consumption and the technological effect (the specific energy consumption for one percentage of quality), appears in Figure 2, in the variant resulting from experimental research and from the quadratic interpolation curve, given by (2):

$$E\,/\,Ecsm(n) = -0.000046404n^2 + 0.0014n + 0.1845\,, \tag{2}$$

It is noted that even energy consumption specific to the unit of technological effect does not present optimal points in strict sense. As the interest is to minimize this ratio, the calculations indicate towards the right extreme of the variation of rotation speed, ie to a maximum, but limited by the kinematic condition, which requires a subunitary value of the kinematic index.

The search for possible optimal points can continue with the other important quality factor, the percentage of good grains lost in subproducts, that has to be minimized. The variation of this quality parameter with the rotation speed appears in Figure 3, also in the variant resulting from experimental research and interpolation curve, given by:

$$Cpsm(n) = 0.009n^2 - 0.4832n + 7.3431\,. \tag{3}$$

It is noted that on the quadratic interpolation curve appear a minimum, in strict sense, at rotation speed: 26.853 *rpm*.

In order to combine the qualitative effects and achieve an optimum point which meets simultaneously the technological effect (whom has to maximize it) and the percentage of good grains lost in subproducts (which has to be minimized), we will study the variation of the ratio between these two parameters, for which we want and get a maximum, as shown by the graphical representation of its variation depending on the rotation speed of the indented cylinder separator, in Figure 4. The optimum point for this quality parameter of the finished product is around 27 *rpm*.

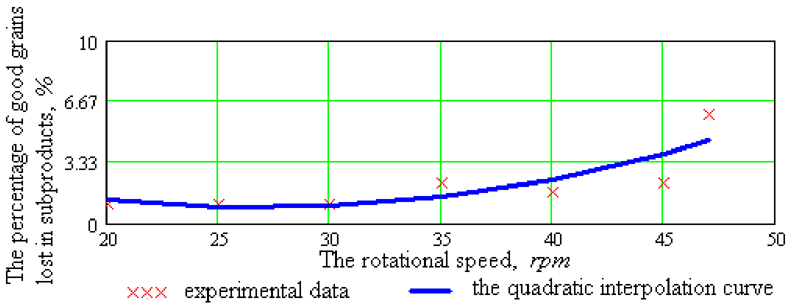

Fig. 3 - The variation of the percentage of good grains lost in subproducts depending on the rotation speed of the indented cylinder

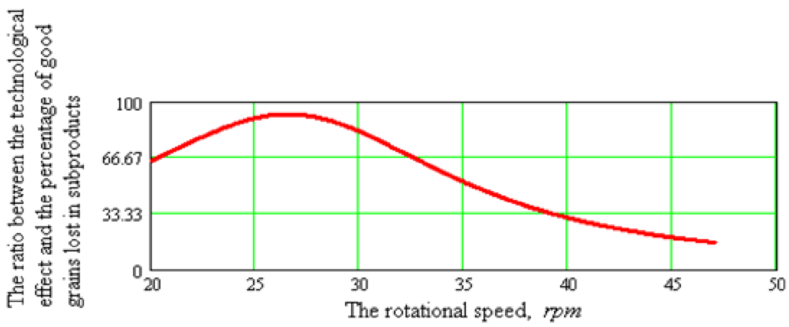

Fig. 4 - The variation of the ratio between the technological effect and the percentage of good grains lost in subproducts, depending on the rotation speed of the indented cylinder

If the energy consumption is reported at technological effect divided by the percentage of good grains lost in subproducts, is obtained an optimal point that minimizes also the energy consumption for a satisfactory quality at a rotation speed around 27 rpm. This fact is seen from the graphical reprezentation of the variation of this last qualitative parameter, which is shown in Figure 5.

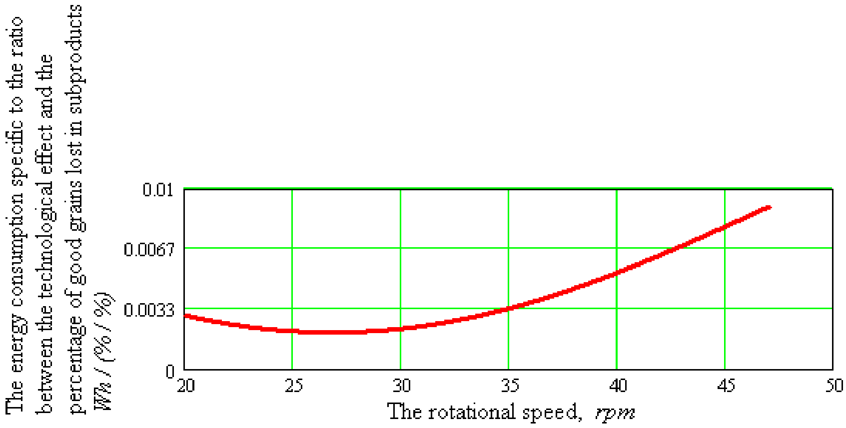

Fig. 5 - The variation of energy consumption specific to the ratio between the technological effect and the percentage of good grains lost in subproducts, depending on the rotation speed of indented cylinder

4. CONCLUSION

From the experimental data and interpolation curve results that:

- ✓ the technological effect decreases with increasing rotation speed and within the limits of working intervals, the maximization (ie optimization) occurs in the far left (lower) range of rotation speed, respectively at the minimum considered rotation speed;
- ✓ the energy consumption specific to the unit of technological effect decreases with increasing rotation speed and within the limits of working intervals, the maximization (ie optimization) occurs in the far right (upper) range of rotation speed, respectively at the maximum considered rotation speed but limited by the kinematic condition, which requires a subunitary value of the kinematic index;
- ✓ the percentage of good grains lost in subproducts has a minimum, in strict sense, at rotation speed: 26.853 *rpm*;
- ✓ the ratio between the technological effect and the percentage of good grains lost in subproducts has a maximum, in strict sense, at rotation speed around 27 *rpm*;
- ✓ energy consumption specific to the ratio between the technological effect and the percentage of good grains lost in subproducts has a minimum, in strict sense, at rotation speed around 27 *rpm*.

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