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Criteria for Evaluating the Efficiency of Domestic Solid Waste Grinding Machines

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ABSTRACT

The article analyzes the types of collection and transportation of household solid waste, as well as the impact of the type of collection on the structure of the shredder. Grinding and processing of solid household waste makes it possible to extract useful components for further use, and the effectiveness of evaluation is discussed.

Introduction. The greatest objective criterion of the truth and usefulness of all new things is human experience. But it is not always possible to carry out a long-term and technical review of each new technical decision. Therefore, in various fields of science and technology, including in the evaluation of new technology in the field of processing of mineral raw materials, in order to optimize the management of production process information, to compare and select appropriate technological schemes, developed parameters of machines or to optimize a certain technological process. criteria are proposed.

Currently, most household waste comes from high-rise residential areas. In spite of the construction works, all the wastes are being collected together. To prevent this, various places have been established in front of multi-storey buildings. In addition, separate collection boxes are placed in the places where these wastes are collected, which are useful in waste processing.

The criteria for evaluating the efficiency of all machines used in the processing of mineral raw materials can be divided into technical, economic and quality criteria. In addition, there are complex or universal criteria. Technical efficiency in the processing of solid household waste, especially waste with organic content, is the sum of the mechanical actions of processing machines based on expediency and intelligence (rational), or the dynamic characteristics of the movement of the material being processed in grinding or other technological practices, that is, in the final process of work, the exact physical - means obtaining the intended product with mechanical characteristics. The first one characterizes the process at a specific position (for example, at some point in the cycle), and the second one at the last time interval. Differential criteria include power, maximum and minimum loads, acceleration, and so on. It is difficult to use them in the optimal technical solution of processing systems or in their optimization, because there are enough such criteria, the optimal options of the system differ according to different criteria, and it is difficult to distinguish the most basic one among them.

The integral criteria of mechanical systems include: work productivity in one shift, one month, one year, efficiency, energy and raw material consumption, relative power, metal consumption, useful work coefficient, reliability in use, average value of kinematic and dynamic characteristics, etc. But they are different in terms of content, there are no general recommendations on when and in what cases these criteria can be applied. A number of dynamic integral criteria have been proposed by many authors for the optimization of various types of mechanical systems. They find various names: energy consumption, performance and power mode, raw materials and energy consumption [1, 2], power, long-term endurance, stability, reliability [3], KPD, etc. With the development of multi-criteria optimization of mechanical systems, generalized criteria obtained by turning several complex criteria into one appeared, which are the constituents of complex criteria and are the same as the given system of proposals.

In the search for optimal parameters of mechanical systems, the Sobolya-Statnikov [4] method has become widespread, it is based on the following:

1. Design tasks according to multiple criteria. There are many criteria, the improvement of which the client is interested in.

2. It is not possible to describe the solution of the allowed options, which fully takes into account all the purposes of processing and the creation of a mechanical system, brings the issue to one criterion.

In essence, the Sobolya-Statnikov method is a method for determining the many solutions that have arisen, their informal analysis, and performing the optimal option of the created mechanical system. It allows taking into account as many criteria as the application developer considers necessary for the complete optimization of the system.

The most common integral criterion for evaluating a processing device is the criterion of processing efficiency (in a day, in a month, in a year). But this criterion does not fully take into account energy consumption, the metal capacity of the device in use, the cost of expenses and many other indicators. Naturally, this indicator is not suitable for comparing different processing systems[7-10].

Materials and Methods. However, performance criteria and energy consumption criteria are the same criteria, which are suitable for the optimization of the technological process of a set of pre-agreed devices. In this case, it is appropriate to optimize the parameters of this device.

Currently, the cost of 1 m3 of the obtained product is the main criteria for evaluating the efficiency of various processing methods of technological machines. The cost value is calculated taking into account the costs necessary to ensure the processing process, such as: wages, electricity, materials, depreciation, transport services, repairs, etc.

This criterion is more universal and objective.

The desire of researchers to combine several criteria has led to the creation of the direction of multi-criteria optimization. There are two ways to solve these problems.

The first way is the matching method, in which the effectiveness of the selected K_1, K_2, ..., K_n criteria is determined through the structural criterion.

$$\sum_{j=1}^{n} K = a_1 K_1 + a_2 K_2 + ... + a_n K_n \qquad (1)$$

here are the efficiency coefficients (weight) of individual criteria.

Attempts have been made to develop generalized criteria, in other words, generalized indicators of efficiency to evaluate the efficiency of road and construction machinery, including grinding machines [5].

The essence of the method is as follows: in the development of a new technique, it is appropriate to establish the latest efficiency on the basis of close links, it serves as the basis for the formation of a systematic analysis of the evaluated object. The systematic classification system of the object in accordance with the main subsystem groups of the machine allows to consider the listed costs in the form of soums to characterize the specific group of the bridge machine:

1) allows to create costs of the energy system, the value of which is proportional to the value of the first approximate power of the installed electric motor;

2) when creating the structural technological and functional costs of the machine, its constructive performance (working bodies, frame, automation, etc.) is determined proportionally to the mass of the machine (traction force).

Z value can be visualized in the following summation form.

$$Z = b_0^1 + b_1 N + b_2 G \qquad (2)$$

here, b_0^1 –is the value related to the impact of structural parameters and economic factors that do not depend on the mass and power of the machine, and is a component of the listed costs, soums/hour; b_1, b_2 –coefficients determining capital and operating costs corresponding to the unit of machine mass and engine power per working hour, soums/(kW×h) and soums/(t×h).

It is possible to present the theoretical model of all these costs in the proposed form, which confirms the analysis of the results of statistical information. The given cost determination expression is treated as an objective function and power and mass are treated as determining factor(s).

The second $K_{Г.Л} = K_1$, way is to determine the main criterion of efficiency, and then try to convert it into another form of maximum (minimum), setting some restrictions on the manifestations of other (auxiliary) criteria.

$$K_2 = k_2,\ K_3 = k_3,\ \ldots, K_n = k_n$$

here, k_1, k_2,..., k_n- some values of the specified parameters should not be larger or smaller than the given criterion in terms of suitability.

The analysis of the specified directions of multi-criteria optimization shows that the accuracy of the adjustment method depends on the completeness of the calculation and the consideration of the degree of influence of each factor on the efficiency of the mechanical system. The analysis of the above two methods for determining the efficiency criteria of a machine designed for the development of a shredder designed for crushing solid household waste shows that none of the above methods is technically, economically, socially and environmentally does not meet the requirements.

Based on the specification of the problems to be solved, optimization of energy capacity, material capacity, etc. according to the first integral method in determining the efficiency criteria of the designed machines. It is appropriate to determine the technical and economic parameters.

Therefore, the assessment of efficiency and technical level based on the given relative costs requires preset values of coefficients b_0^1, b_1, b_2 in formula (2). This complicates the evaluation process.

$Z_У$ we generate the value; Z if $П$ we divide by $N_{УД}$ and $G_{УД}$ put the values outside the $Z_У$ parentheses, we get , soums/product unit.

$$Z_У = k_{b_o} \times k_{b_1 b_2} \frac{N_{УД}}{П_{Т.УД}}, \qquad (3)$$

Here

$$k_{b_1 b_2} = \frac{b_1}{G_{УД}} + \frac{b_2}{N_{УД}}; \qquad b_0 = \frac{b_0^1}{П_Т}. \qquad (4)$$

The indicated efficiency indicator (criterion) is equivalent to energy capacity and material capacity indicators. b_0, b_1 and b_2 for a group of machines with constant values of the coefficients, it will be possible to evaluate the efficiency and technical level of the system according to general indicators.

$$П_{NG} = \frac{N_{УД}}{П_{Т.УД.}} \qquad (5)$$

The general indicator $N / П_Т$ is a quantity equal $П_Т / G$ to the ratio of relative energy capacity to relative work efficiency. $П_{NG}$ a decrease in the indicator means an increase in system efficiency.

Thus, $П_{NG}$ the smaller the value, the greater the efficiency of the grinding machine. But it should also be taken into account that there are other criteria that cannot be presented in the form of a numerical expression. We are talking about the efficiency of the car from the point of view of ecology. It is clear that the minimization of this criterion is the solution to this problem. [6]

Installed power of the electric motor according to the output of fine fractions (kW)

$$N = \frac{Q\left[\omega_{R_i}(\gamma_i^1 - \gamma_i) + 0{,}0004\vartheta_P^{1,5}\right]}{\eta_{ДР}\eta_П}, \qquad (6)$$

here ω_{R_i} – is the energy indicator, kW s\t; ϑ_P – the rotation speed of the rotor of free-discharge grinders (without grid), γ_i^1, γ_i – the part of the fraction (0...i) in the grinding product and in the starting material, respectively, determined from the graphs of the composition; $\eta_П$ – FIK of the procedure.

The selection of the sizes of fine fractions is determined by the size of the grinding. It is recommended to take the size of small fractions of 0-7 mm for coarse grinding, and 0-0.25 mm for small grinding. At the same time, it should not be ignored that it is somewhat difficult to determine the amount of small fractions in the composition due to their significant dusting.

Results. Research the main indicators of the grinding process in relation to:

- the angle of installation of the rotor hammers in relation to the axis passing along the length of the rotor;

- rotation speed of the grinder rotor;

- the mass of the hammer;
- the diameter of the hole of the columnar grid.

Based on technological concepts or information not seen in experience, restrictions were placed on some parameters of the crusher, for example, the diameter of the rotor of the crusher - its value is limited by the inner diameter of the wall of the crusher body, or another example, the power of the crusher is limited to the strongest of waste constituents. and so on.

Development of a physical model of a hammer crusher and optimization of its main parameters and operating mode.

Determining the economic efficiency of the hammer grinder.

To analyze the economic efficiency of a hammer crusher, as mentioned above, information on energy capacity and material capacity is necessary.

To analyze the economic efficiency of a hammer crusher, as mentioned above, information on energy capacity and material capacity is necessary. For this purpose, it is necessary to calculate the value of work productivity and energy consumption. In the setting of ecological restrictions, for example, secondary pollution of the environment, the criterion of the hammer crusher's performance is the minimum pollution of the environment when crushing organic waste to the required size.

It has been emphasized many times above that the characteristics of the waste have a significant effect on the mode indicators and construction of hammer mills. For this purpose, samples were taken from waste collection sites. 10 waste collection points were selected to study the morphological structure of the WWTP. The mass of each selected sample is 30 kg. The methodology for determining the morphological composition of household waste was as follows: the waste was leveled in the armor with dimensions (2000 2000), after leveling, the armor surface was divided into four parts, ¾ of the waste was thrown away, and ¼ was sent for analysis (method of quartering (the unit of measurement of the volume of liquid and scattering bodies).

After that, the analyzed part of the waste was leveled on the armor, and each component of the waste was separated separately. The percentage composition of waste constituents was determined by the following formula.

$$Y_1 = \frac{A_1}{B_1} \times 100\% , \qquad (7)$$

here, Y_1 – the composition of waste constituents in percent, %; A_1 – mass of waste constituents, kg; B_1 – total mass of waste, kg.

The value of the components of solid household waste - fractional content cell sizes 250 250; 150 150; 100 100; 50 50; 15 15 mm sieve mass is determined by successive spraying of a sample of 30 kg.

The criterion for evaluating the quality of the hammer crusher is the crushed percentage composition of the organic constituents of the waste specified by GOST for the production of compost with low (secondary) pollution of the environment. The experiment was repeated three times for each variant. Experiments were conducted by preparing 10 samples with a mass of 30 kg each.

The percentage of waste crushing was worked out by the following formula.

$$Y_2 = \frac{A_2}{B_2} \times 100\% , \qquad (8)$$

here, Y_2 – is the percentage of shredding of the components of solid household waste to the required size according to GOST, %; A_2 – mass of waste constituents crushed to the required size, kg; B_2 – total mass of waste constituents, kg.

Conclusions.:

The developed methodology of conducting experimental research allows to determine the morphological and fractional composition of solid household waste and the relationship between the morphological composition and the fractional values of the constituents of solid household waste. In addition, the developed methodology makes it possible to experimentally determine the work efficiency of the hammer grinder.

The percentage composition of organic constituents of solid household waste is in the range of 32-34%, and it was experimentally determined that it can be used as a raw material for the production of compost.

The development of criteria for evaluating the efficiency of hammer crushers requires a comprehensive approach that includes technical, economic, social and environmental quality criteria.

Based on the specificity (specification) of the problem to be solved, it is appropriate to optimize the energy capacity, material capacity and other similar technical and economic parameters of the machine under the first integral method in determining efficiency criteria. Therefore, the evaluation of efficiency and technical level based on the mentioned costs requires the values of coefficients b_0, b_1 and b_2 to be known in advance, which complicates the evaluation process.

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