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DEVELOPMENT OF SIMILARITY CRITERIA FOR THE GRINDING PROCESS OF ORGANIC COMPONENTS OF SOLID HOUSEHOLD WASTE ON BALL MILLS

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ABSTRACT

Based on the analysis of grinding process datacomponents of solid domestic waste at ball mills, a list of factors affecting the efficiency of the process of grinding solid domestic waste has been determined. Using the dimensional analysis method. made it possible to determine a list of similarity criteria and draw up a criterion equation for the process of grinding municipal solid waste in ball mills. On the basis of process similarity indicators and scale factors, a physical model of a ball mill is constructed. The data obtained on physical models can be easily transferred to a full-scale object.

Introduction: In the Republic of Uzbekistan, attention to the problem of waste accumulation and processing is increasing. According to the Decree of the President of the Republic of Uzbekistan dated April 21, 2017 No. UP-5024 "On improving the system of public administration in the field of ecology and environmental protection", state control over compliance with legislation in the field of waste management should be carried out. In this regard, in order to solve this problem, the Inspectorate for control over the formation, collection, storage, transportation, disposal, processing, disposal and sale of waste was created at the central office of the Civil Code of the Republic of Uzbekistan on ecology and environmental protection, which is its important task.

According to the tasks arising from the Decree of the President of the Republic of Uzbekistan dated April 17, 2019 No. PP-4291 "On approval of the Strategy for the management of solid domestic waste in the Republic of Uzbekistan for the period 2019-2028", it is necessary:

- to ensure the processing of at least 60% of the generated MSW;
- reduce the amount of solid waste sent for disposal to landfills by up to 60%.

The main direction of solving the above problems is to reduce the volume of waste by grinding and sorting the organic components of the waste in places of accumulation and reloading. But, the complex of machines used in the grinding and sorting of mixed collected waste is not very efficient, especially in terms of product quality, for example, the components of the waste after grinding in hammer mills are much larger than the required dimensions for compost production, to achieve the desired parameters it is necessary, but to use the second stage of grinding, which in turn is costly. In addition, the specific energy and specific material consumption of these machines is very high compared to ball mills.

In connection with the above issues related to the creation of ball mills for grinding MSW with low rates of material consumption and energy intensity is an urgent task [1,2].

Methods and materials: The following factors influence the process of grinding the components of municipal solid waste in ball mills:

- ball diameter D, mm;
- speed n of the ball mill, 1/c;
- the degree of filling the volume of the ball mill with organic constituent waste;
- the average diameter of the organic components of municipal solid waste d before grinding, m;
-mass of balls m, kg;
- linear size L, ball mill, m;
- free fall acceleration g, m/s^2.

If we take as efficiency, productivity Q of a ball mill for the production of refined solid waste with a given size, then the functional dependence between the above parameters can be written in the following functional dependence, in an implicit form

$$Q = f(D, n, \alpha, d, m, L, g, \rho), \quad (1)$$

Equation (1) shows that the process of grinding organic components depends on 9 parameters. But, since the coefficient k is measured in numbers. Then this parameter is a separate criterion. Then based on the π theorem, the number of similarity criteria is 8-3=5. For our case, we choose 3 basic units of measurement, L, ρ, g. As mentioned above, the process is determined by 5 similarity criteria in the first approximation. Using the dimensional analysis method, the meaning of which is as follows. One of the parameters that determine the process is written in the numerator, and these three basic units of measurement are written in the denominator, to the first degree, and we get the following system of criteria:

$$\pi_1 = \frac{Q}{L^{2.5}g^{0.5}};\ \pi_2 = \frac{nL^{0.5}}{g^{0.5}};\ \pi_3 = \frac{D}{L};\ \pi_4 = k_\alpha;\ \pi_5 = \frac{d}{L}, \pi = \frac{m}{\rho L^3}, \quad (2)$$

We will establish the relationship between the scales of physical quantities using the formula for establishing similarity indicators.

To determine the similarity indicator. It is necessary to divide the similarity criterion for nature by the similarity criterion for the model. For example, the relationship of scale k_Q with other scales would be

$$\frac{k_Q}{k_L^{2.5}k_g^{0.5}} = 1.$$

Then we obtain the following series of equations for the relationship between the scales of the parameters that determine the process

$$\frac{k_L^{0.5}k_n}{k_g^{0.5}} = 1;\ \frac{k_D}{k_L} = 1;\ \frac{k_g}{k_L k_n^2} = 1;\ \frac{k_d}{k_L} = 1;\ \frac{k_m}{k_\rho k_L^3} = 1.$$

You must select independent scales. They can be any of the available scales, however, based on the convenience of modeling, it is better to choose independent ones k_L,k_g,k_ρ. Then the remaining scales will be determined on the basis of the obtained equations.

$$k_n = \sqrt{\frac{k_g}{k_L}}, k_D = k_L, k_d = k_L, k_m = k_\rho k_L^3, k_\alpha = 1$$

Based on the conditions for the possibility of setting up experiments, we take k_ρ=k_g=1,

So, as the modeling of the physical quantities ρ and g is very difficult [3,4]. Then the experiments will be carried out under conditions of approximate physical modeling, and the scales of physical quantities will be determined by the linear scale of the model:

$$k_n = \frac{1}{\sqrt{k_L}};\ k_D = k_L;\ k_d = k_L;\ k_m = k_L^3;\ k_\alpha = 1, \qquad (3)$$

To select a linear scale, we will use the recommendations [3].

The model scale limit is defined by:

-permissible volume of the medium interacting with the model of the working body;

-accuracy of measuring instruments.

The analysis of existing equipment for grinding the components of solid household waste from waste processing plants allowed the object of study and, based on the size of the natural object, a linear modeling scale was established, $k_L = 36$

According to the chosen scale, a model should be built and the planned experimental studies should be carried out. When preparing raw materials for experiments, it is necessary to use averaged data on the morphological and fractional composition of waste over the past 3 years, which will serve as a probabilistic model of raw materials. Based on the finished probabilistic waste model, a series of experiments on models are carried out.

The transition from the parameters of the model to the parameters of nature is carried out according to the formulas. Following from the equality of the similarity criteria of the model and nature.

For example, to find the transition formula by the criterion

$$\left(\frac{D}{L}\right)_N = \left(\frac{D}{L}\right)_\text{M} \rightarrow \frac{D_N}{L_\text{M} k_L} = \frac{D_\text{M}}{L_\text{M}} \rightarrow D_N = D_\text{M} k_L,$$

In the same way, we obtain formulas for the transition from the model parameters to the original parameters

$$d_N = d_\text{M} k_L,\ D_N = D_\text{M} k_L, m_N = m_\text{M} k_L^3, \alpha_N = \alpha_\text{M}, Q_N = Q_\text{M} k_L^{2.5}, \quad (4)$$

Conclusions

1. Based on the obtained similarity criteria for dependences (2), taking into account assumptions and limitations, it is possible to construct the dependence of performance on the main parameters of the physical model.
2. With the help of dependencies (4) it is possible to pass from the model parameters to the natural parameters.

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