

DOI: 10.31319/2519-8106.2(43)2020.219262

UDC 621.926.001.66

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SUBSTANTIATION OF THE ALGORITHM FOR MODELING OF THE JAW CRUSHER MECHANISM WITH A SIMPLE MOVEMENT OF THE JAW

The actual scientific problem is solved in the work, which consists in substantiation of the algorithm of modeling of the jaw crusher mechanism with a simple movement of the jaw on the basis of using SOLIDWORKS modelling tools. Empirical equations are obtained, which relate the parameters of the crusher: the height and thickness of the fixed and movable jaws and connecting rod, the length of the spacer plates from the size of the loading inlet, the size of the eccentricity from the stroke of the jaw. It is recommended to use the received regularities at designing the domestic crushers with a simple movement of the jaw.

Key words: jaw crusher; jaw crusher mechanism with a simple jaw movement; eccentricity; movable jaw stroke.

В роботі вирішена актуальна наукова задача, яка полягає в обґрунтуванні алгоритму моделювання механізму щогової дробарки з простим рухом щоки на основі використання інструментів моделювання SOLIDWORKS. Отримано емпіричні рівняння, котрі пов'язують між собою параметри дробарки: висота і товщина нерухомої і рухомої щок і шатуна, довжини розпірних плит від розміру завантажувального отвору, розмір ексцентриситету від ходу щоки. Рекомендується використовувати отримані закономірності при проектуванні вітчизняних дробарок з простим рухом щоки.

Ключові слова: щогова дробарка; механізм щогової дробарки з простим рухом щоки; ексцентриситет; хід рухомої щоки.

Problem's Formulation

Jaw crushers with a simple movement of the jaw are produced by factories [1—4]: CJSC “Avtokompozyt” (trademark “Drobmash”, Viksa), PJSC “Volgotsem mash” (Tolyatti), machine-building corporation “Uralmash” (Yekaterinburg). On the territory of Ukraine, only the production of jaw crushers with complex jaw movement is established, and jaw crushers are not produced. The analysis of the state of the issue shows that there is a fundamental difference in the designs of the same typical sizes of crushers. The sizes of an outlet (the size of the crushed material), the stroke of a movable jaw, the size of eccentricity, coordinates of fixed supports, overall dimensions differ. This suggests that there is no unification despite the presence of state standard (DEST).

Analysis of recent research and publications

The analysis of the literature shows that the magnitude of the stroke of the movable jaw is determined by different ratios. For example, in Bauman's book [2] the stroke of the movable jaw s is determined by the ratio $s = (0.04...0.065)B$; in Klushantsev [3] $s = (0.01...0.03)B$; in Dunaiev [4] $s = (0.03...0.035)B$. In addition, according to the recommendations of Klushantsev [3] the size of the eccentricity is approximately equal to the stroke of the movable jaw, while Bauman with the reference to the study VNDIdormash [2] which states that the stroke should be twice the size of the eccentricity.

In order to determine the basic geometric parameters of jaw crusher (height and thickness of fixed and movable jaws and connecting rod, the length of the spacer plates from the size of the loading inlet, the size of the eccentricity from the stroke of the jaw) it is necessary to solve an urgent scientific problem, namely, to substantiate the algorithm for modeling the mechanism of the jaw crusher with a simple movement of the jaw.

Formulation of the study purpose

The purpose of this work is to create sound recommendations for the design of a jaw crusher with a simple movement of the jaw, to determine the geometric dimensions of the mechanism of the jaw crusher with a simple movement of the jaw.

Presenting main material

Using modern SOLIDWORKS modelling tools, we will determine the relationship between the size of the eccentricity and the links of the mechanism of jaw crushers with a simple movement of the jaw and the stroke of the movable jaw. As a basic design we accept crushers size 900Ч1200 [1—4].

Fig. 1 shows a cross section of a jaw crusher with a simple movement of the jaw, as well as its model. Here it is marked: fixed jaw I — is modelled by a rod hinged in nodes 1 and 2; movable jaw II — is represented by a T-shaped rod (O1-3-5-6), which is hinged in node O1; front spacer plate III — is depicted in the form of a rod 6-7; rear spacer plate IV — is marked with rod 8-O3, hinged in node O3; connecting rod V — is presented in the form of a T-shaped rod (7-8-9-10); eccentric shaft VI — is modelled by a 10-O2 rod, which is hinged in O2 node.

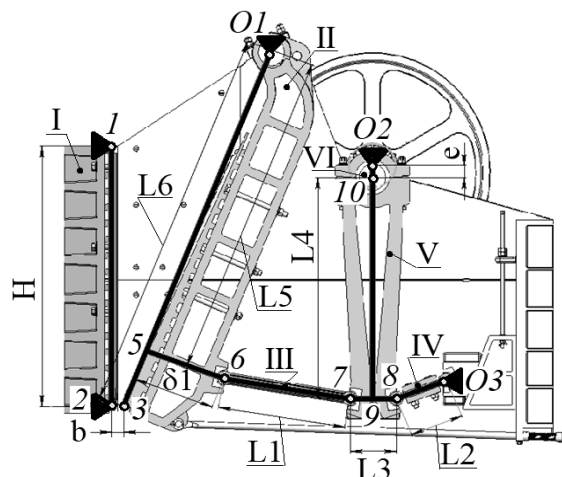


Fig. 1. Model of a jaw crusher with a simple movement of a jaw

To build the mechanism, we use the data given in literature [1—4], where it is known: the overall dimensions of the crusher; flywheel diameter; the stroke of the movable jaw $s = (0.03 \dots 0.035) B$; the size of the outlet b ; the connecting rod and the eccentric must occupy a vertical position in the open state of the slot of the outlet. For the closed state it is known only that the connecting rod and the eccentric must be collinear; the angles of inclination of the spacer plates to the horizon should be 10° ; the width of the inlet B ; the lower points on the fixed and movable jaws are horizontal. In order to fully determine the mechanism of JCS it is necessary in addition to the sizes $B, H, b, s, L1, L2, L3, L4, L5, L6, \delta$ and $\delta 1$ to determine the value of the eccentric e coordinates of fixed supports $XO1, YO1, XO2, YO2, XO3, YO3$.

Based on the above conditions, we construct a jaw crusher mechanism of the size 900Ч1200 according to the following algorithm [5]. Let's start with the open state of the mechanism. On the sketch we will create a rectangle which symbolizes the overall dimensions of the crusher. From data [1—4] it is seen that the thicknesses of the fixed jaw and the rear support plate are equal and for this crusher are 600 mm. This factor was taken into account when creating the sketch (Fig. 2). Here the overall dimensions of the crusher and the diameter of the flywheel are indicated by dash-dotted lines.

Construction of the open position of the crusher mechanism. From the origin of the coordinates we draw vertically down segment 1-2 of length H . From point 2 to the right at a distance b we note point 3, and from the origin of the coordinates at a distance B — 4 (the size of the loading inlet 900 mm). Through points 3 and 4 we construct a segment of length $L6$ (without reaching a bounding rectangle). The position of the upper point of the segment $L6$ corresponds to the position of the fixed

$$\begin{aligned}
 L2 &= 0.656 \cdot B, \\
 L3 &= 0.417 \cdot B, \\
 L4 &= 1.433 \cdot B, \\
 L5 &= 2.089 \cdot B, \\
 L6 &= 2.983 \cdot B, \\
 \delta 1 &= 0.833 \cdot B.
 \end{aligned}$$

Next, determine the dependence of the size of the eccentricity on the stroke of the movable jaw of the crusher. For this purpose, the value of the eccentricity value in the range from 1 mm to 100 mm was changed on the constructed models (Fig. 2—3) and the value of the jaw stroke was measured.

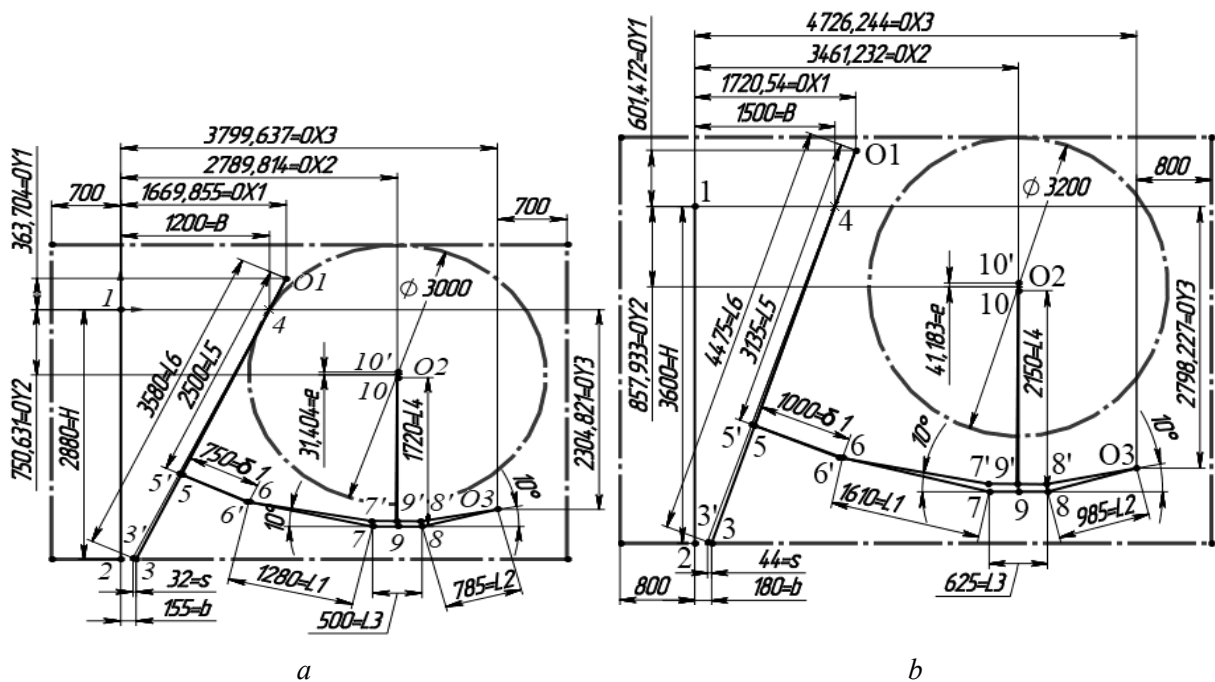


Fig. 3. The mechanism of the crusher: *a* — for crushers sizes 1200x1500; *b* — for crushers sizes 1500x2100

Based on the results of the study, we construct a graph of the dependence of the value of eccentricity on the stroke of the movable jaw (Fig. 4). After analysing these graphs of dependence, we obtain approximation polynomials of the influence of the value of eccentricity on the stroke of the movable jaw of the form:

- for crushers sizes 900x1200 $e(s) = 1.081 \cdot s + 0.076$,
- for crushers sizes 1200x1500 $e(s) = 1.064 \cdot s + 0.055$,
- for crushers sizes 1500x2100 $e(s) = 1.021 \cdot s + 0.051$.

Conclusions

The analysis of the literature shows that there is no unambiguous information on the choice of the parameters of the jaw crusher mechanism with a simple movement of the jaw that affect the kinematics of the movable jaw.

The actual scientific problem has been solved in the work, which consists in substantiation of the algorithm of construction of jaw crusher mechanism with a simple jaw movement on the basis of the use of the tools of SOLIDWORKS modelling.

Empirical equations have been obtained which relate the parameters of the crusher: the height and thickness of the fixed and movable jaws and connecting rod, the length of the spacer plates from the size of the loading inlet, the size of the eccentricity from the stroke of the jaw.

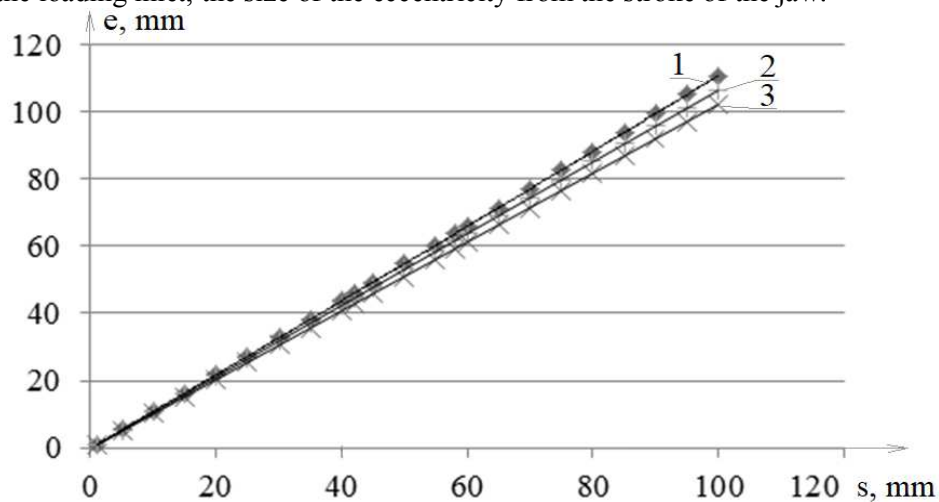


Fig. 4. The dependence of the magnitude of the eccentricity on the stroke of the movable jaw for different typical sizes of crushers

It is recommended to use the received regularities at designing domestic crushers with a simple movement of the jaw.

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ОБҐРУНТУВАННЯ АЛГОРИТМУ МОДЕЛЮВАННЯ МЕХАНІЗМУ ЩОКОВОЇ ДРОБАРКИ З ПРОСТИМ РУХОМ ЩОКИ

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Реферат

В роботі вирішена актуальна наукова задача, яка полягає в обґрунтуванні алгоритму моделювання механізму щоккової дробарки з простим рухом щоки на основі використання інструментів моделювання SOLIDWORKS.

Метою роботи є створення обґрунтованих рекомендацій щодо проектування щоккової дробарки з простим рухом щоки, визначення геометричних розмірів механізму щоккової дробарки з простим рухом щоки.

Для визначення основних геометричних параметрів ЩДП (висота і товщина нерухомої і рухомої щок і шатуна, довжини розпірних плит від розміру завантажувального отвору, розмір ексцентриситету від ходу щоки) потрібно вирішити актуальну наукову задачу, а саме обґрунтувати алгоритм моделювання механізму щоккової дробарки з простим рухом щоки.

Отримано емпіричні рівняння, котрі пов'язують між собою параметри дробарки: висота і товщина нерухомої і рухомої щок і шатуна, довжини розпірних плит від розміру завантажувального отвору, розмір ексцентриситету від ходу щоки.

Отримані закономірності, що пов'язують розмір ексцентрика з ходом рухомої щоки, а також геометричні розміри ланок механізму дробарки, перспективно використовувати при проектуванні вітчизняних дробарок з простим рухом щоки.

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