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Vladimir I. MOROZOV
Vladimir D. BARDOVSKY
Moscow Mining Institute

SELECTION CRITERIA FOR DETERMINING THE PARAMETERS OF CRUSH-GRADING MACHINES

Summary. There aren't general criteria determining the combined effectiveness of crushing and grading machines. Selection of these machines could only be judged at the processing plant depending upon the predictability to meet the required standards and the product volume. This approach neglects power input, wear and many other factors. In order to get comparison on effectiveness of a different combination of mineral crushing and grading machines the integrated index Q was introduced. Among the analysed combinations of crush-graders the most effective is that with the lowest value of the index Q.

KRYTERIUM DOBORU PARAMETRÓW MASZYN KRUSZĄCO-SORTUJĄCYCH

Streszczenie. Dotychczas nie opracowano kryterium dotyczącego oceny trwałościowej zestawu maszyn kruszących i sortujących. Wybór zestawu tych maszyn może być oceniany tylko w zakładzie przeróbczym w oparciu o jakość i wielkość produktu końcowego. To podejście do oceny systemu nie uwzględnia poboru energii, zużycia elementów systemu i wielu innych parametrów. W celu uzyskania porównania sprawności różnych zestawów maszyn kruszących i sortujących wprowadzony został zintegrowany współczynnik Q. Wśród analizowanych zestawów maszyn krusząco-sortujących najbardziej sprawny okazał się ten, dla którego wartość współczynnika Q była najmniejsza.

AUSWAHLKRITERIUM, DIE ZUR BESTIMMUNG DER KENNGRÖßEN VON ZERKLEINERUNGS - UND SORTIERMASCHINON GEEIGNET SIND

Zusammenfassung. Bischer is nach kein für die Beusteilung der lebensdaner eines ausgewähten Satzes von Zerkleinerungs - und Sortiermaschinon geeignetes Krtiterium entwickelt worden.
Die - Auswahl der einen solchen Satz bildenden Maschinen kann nur in einer Auffbereitungsanlage auf Grund der Qualität und der Merge des Endproduktes beirteilt werden.
Bei dieser Einstellung zum Problem der Beusteilung des Systems werden die Energieaufnahne, der Verschleiß von Elementen des Systems und wiele anderen Kenngrößen in Betracht nicht genommen.
Um ein Verleich der Leistungsfähigkeit von verschiedenen Sätzen der Zerkleinerungs - und Sortiermaschinen möglich zu machen, hot man einen integrierten Faktor Q eingeführt.
Der Satz der Zerkleinerungs und Sortirmaschinen der durch den niedrigsten Wert des Faktor Q gekennzeichnet ist, hot sich als der am meisten leistungsfähize Satz unter den analysierten Systemen der Zerkleinerungs und Sortirmaschinen erwiesen.

The basic types of machines for processing mineral wastes are crushers and grading machines. To these machine groups belong the following: conical roll crushers; pound-crushers; spherical type crushers; bar crushers; vibration crushers; centrifugal and planetary crushers; vibration type graders; griddle screen with fixed sifts; hydroseparators; pneumatic separators and others. For clearity, there is no distinction as regards the combined effectiveness of these machines, for concrete exploitation conditions; there aren't general criteria determining the combined effectiveness of these machines.

The right selection could only be judged at the processing plants depending upon the products ability to meet the required standards and by the processed mineral volume, therefore this approach of determining the efficiency of combining these machines neglects, power inputs, wear and tear and many other factors. Apart from these, mineral crush - graders are not used according to specified conditions.

The previous work [1] presents the index $[x_{ij}]_{\xi\nu}$, an optimization criterion of a mining process.

Thus:

$$[x_{ij}]_{\xi\nu} = \frac{\{B_{ij}\}_{\xi\nu}}{[\lambda_{ni}]_{\xi}} \to \min, \tag{1}$$

where $\{B_{ij}\}_{\xi\nu}$ - represents a finite set of j-th indices for a mining process of an i-th machine for ν-th hierarchy;

$|\lambda_{ni}|$ - main functional parameter of an i-th machine;

ξ - calendar period calculated upon the specific input.

It is noticeable that the most effective combination od mineral crushers and graders would be that which requires a minimal input i.e. labour and material resources which determines the end results. Whilst organizing and carrying through a technological cycle of mineral waste processing, it's necessary to ensure a minimal specific input whilst conforming to the regulations towards attaining the desired product quality.

The criterion for comparing the effectiveness of different methods based in boring is abased on the least action principle, which objectively reflects it technical-technological features has been worked out in work [2].

Analogically, [3] for comparing the efficiencies of different combinations of mineral crush-grading machines we introduce an integrated index Q, calculated as follows:

$$Q = F^{y}p(c)t_{p}(c)L_{p}M_{p}(c), \tag{2}$$

where:

p(c) - "crusher (grader)";

y - "conditional";

$F^{v}_{p(c)}$ - the total average conditional resistance, originating during mineral waste crushing (or grading)

$t_{p(c)}$ - average duration of passing a given volume of material throught the working section of the crusher or grader;

$L_{p(c)}$ - conditional length of the working organ of the crusher or grader;

* conditional length means the distance, a given volume of material moves during crushing or grading;

$L_{p(c)}$ - $V_{p(c)} \cdot t_{p(c)}$ where $v_{p(c)}$ - average velocity of the material through the working organ;

$M_{p(c)}$ - total mass of crushers or graders combined.

Let's find out what makes the integrated index Q. The total power required by the crusher and grader combined during mineral waste processing:

$$N = dA/dt, \tag{3}$$

where A is total work input; t - time.
Then

$$A = \int_{0}^{t_{p(c)}} \cdot\, dt. \tag{4}$$

Total work (energy input)

$$A = F^{v}_{p(c)} L_{p(c)}. \tag{5}$$

From formulae (4) and (5).

$$F^{v}_{p(c)} = \int_{0}^{t_{p(c)}} N dt \cdot L^{-1}_{p(c)}\ . \tag{6}$$

In this manner total conditional resistance is represented as a force that integrally reflects the total resistance of the crush-graders which should be overcome during operation. In reality such a resistance is non-existent and therefore it is experimentally impossible to determine.

If the conditional resistance $F^{v}_{p(c)}$ is impossible to determine, then the total energy spent during a crush-grading process becomes determinable. Considering formula (6), equation (2) is represented as

$$Q = A \cdot t_{p(c)} M_{p(c)}. \tag{7}$$

Therefore

$$A = N^{Qv}_{p(c)} t_{p(c)}, \tag{8}$$

where $N^{Qv}{}_{p(c)}$ - average power required for processing mineral wastes on a crush-grader, i.e.,

$$Q = N^{Qv}_{p(c)} t^2_{p(c)} M_{p(c)}. \tag{9}$$

In expressions (8) i (9)

$$N^{Qv}_{p(c)} = t^{-1}_{p(c)} \cdot \int_{Q}^{t_{p(c)}} N dt \approx t^{-1}_{p(c)} \sum N_{p(c)} t'_{p(c)}. \tag{10}$$

where N^{qv} and $t_{p(c)}$ are accordingly the required power and passage duration of the material through the working sections (organs) of the crush-grader (screening) working under specific conditions.

The index Q in formula (2) embodies four factors (components): force, displacement, time and mass. Since the Q embodies a force factor, it could be classified as a measure of interaction.

Index Q as a measure of interaction which conforms with the measure of motion as widely used in variation principles in mechanics is often called action [8].

From L-Granges formula:

$$D(T) = \int_{T_1}^{T_2} L(x,\dot{x},T)dT \to \min, \tag{11}$$

where:

D(T) - represents the system's action from time T_1 to T_2

L - L'Grangin; x - coordinate, $\dot{x}$ - system's velocity.

The universality of this measure of interaction embraces the fact that if any force acts on a system of material points the system will move on a trajectory along which the action by L'Grange would be minimal.

This property of action could be equated to the measure of interaction i.e. index Q. Amongst the compared combinations of Crush-graders of mineral wastes the most effective is that with the least value of index Q.

The dimension of index Q is expressed in n m sec kg or kg^2 m^2 sec^{-1} which does not correspond to the dimensions of any mechanical quantity. Therefore index Q has only an auxillary meaning.

Thus for presenting a comparative combination of crush-graders for processing specific mineral wastes of mineral are under the same conditions of exploitation, it's necessary to have the following: the total energy(power) spent during a crush-grading process; total duration for the materials to pass throught the crush-grader; total mass of the crush-grader.

In determining the efficiency of crush-graders, indices like productivity, time-expenditure and power used on other secondary operations (transportation etc.) need not be calculated.

From existing data we can make comparisons, of the efficiency of different combinations of crush-graders for processing mineral wastes and sifting of non minerals (building materials) using the index Q. Results of calculations are tabulated below.

Table 1

Table for different combinations of crush-graders for non-minerals with initial volume - 0,1 m^3 obtained from the criteria Q

Combined crushers and graders	Total mass of crush-graders tons	Total power, kW	Average duration, hours	Criteria Q
(Pound} crusher - vibration sift	7,5	65	2,7	3554
Vibration crusher- -pneumatic classi-fier	27,1	27,2	1,3	1246
Planetary crusher - arched screen grader	1,2	5	12,1	878
Spherical (ball) crusher - vibration grader	10,4	32	2,8	2600
Spherical (ball) crusher - pneu-matic classifier	30,7	49	1,4	2948

From the table, the effective combinations of crushers and graders are: the planetary crushers - arched-screen grader and the vibration crusher - pneumatic classifier.

LITERATURE

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Recenzent: prof. dr hab. inż. S. Ścieszka

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