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EFFECTIVE ENERGY UTILISATION WITH THE EXCAVATOR WHEEL

Summary. The optimum utilisation of energy supplied to the excavator wheel rests upon the optimisation of mode parameters of breaking aimed at diminishing the energy demand of the mining process at keeping theoretical efficiency. The solution proposed is based on the determination of basic dimensions of the cut mined, especially the width-depth ratio according to the criterion of minimum specific energy by volume.

EFEKTYWNE WYKORZYSTANIE ENERGII NA KOLE KOPARKI

Streszczenie. Optymalne wykorzystanie energii dostarczonej do koła koparki polega na doborze optymalnych parametrów urabiania prowadzących do zmniejszenia zapotrzebowania energii procesu urabiania przy zachowaniu jej teoretycznej wydajności. Proponowane rozwiązanie oparte jest na określeniu podstawowych wymiarów skrawu, szczególnie stosunku szerokości do głębokości zgodnie z kryterium minimum jednostkowej energii urabiania.

1. Analysis of Factors Affecting the Conditions of Wheel Excavators

The final effect of any mining process is achieving the maximum efficiency, which represents, in the case of exploitation by wheel excavators that are part of the equipment complex, efficiency by volume corresponding to the maximum utilisation of all machines included into the equipment complex. The theoretical efficiency of the excavator determining the theoretical volume amount of broken (loose) rock per unit time is a technical parameter of the machine and is directly proportional to the geometrical volume of the bucket and the number of bucket tips [1]. The final effect of excavator efficiency is affected by many parameters that are not only technical, as can be seen in Fig. 1.

Digging resistances are a result of rock-wheel interaction; their magnitudes will depend, in addition to the kind of rock broken, on the shape and the size of the cut, on the number of buckets engaged, and thus also on the length of cutting edges. The number of buckets engaged is one of the factors affecting on the one hand the capacity of the excavator, and on the other hand, the breaking force per bucket. The analysis of these factors shows hat from the point of view of energy demand, it is mode parameters determining the shape and the size of the cut mined that can influence markedly the final effect of the mining process – theoretical efficiency.

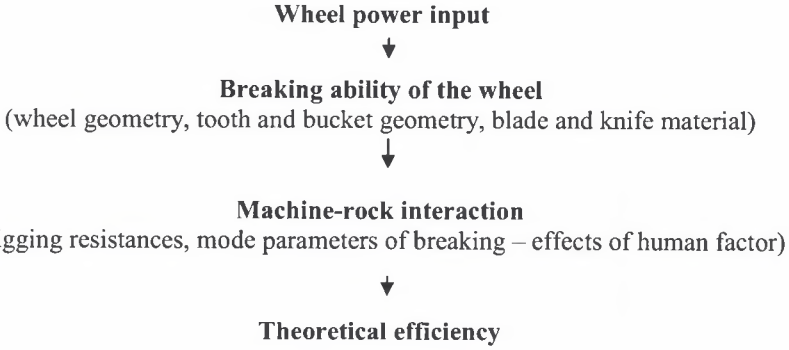

Fig. 1. An overview of factors affecting the theoretical efficiency of excavators
Rys.1. Czynniki mające wpływ na teoretyczną wydajność koparki

The final effect of the mining process – theoretical efficiency – is influenced, in various degrees, by the mentioned factors, and energy consumption required for achieving it can be of different values.

2. The Effect of Crucial Parameters on the Efficiency of Wheel Excavators

The efficiency of wheel excavators and energy demand of the mining process are directly proportional to *digging resistances*. This technological quantity expressing *machine – rock* interaction depends on the set of input quantities:

a/ constants

- *geological factors (rock)* – they are expressed by a set of technical and petrographic properties,
- *the other influences* - they are a set of prevailingly non-influenceable factors,

b/ variables

- *technical factors* – they are given by properties of the breaking tool that is determined by a breaking technology,
- *technological factors* – are determined by mode parameters (wheel rpm and the rate of turning the superstructure).

It follows from the analysis of the mentioned factors that merely the technological factors can offer possibilities of solving energy conditions in mining. Generally, the technical efficiency of bucket wheel excavators depends on basic technical parameters and mining conditions. In reality, the human factor – the driver of the excavator - influences it markedly. Adjustable parameters influencing directly the theoretical efficiency and energy consumption are, in principle, dimensions of the cut produced. It follows from the presented analyses that the human factor affects markedly the efficiency of the mining process.

In virtue of the analysis of completed theoretical and practical researches orientated towards breaking processes and objectiveness proving when used *in situ* (at drilling and tunnelling), the most objective present-day evaluation quantity is minimised specific energy by volume. Then the digging resistance will be defined as "the amount of energy consumed by breaking the unit volume of rock per unit time and by overcoming other resistances on the wheel, while mode parameters are regulated to ensure the minimisation of this specific energy" [2]. The digging resistance defined in this manner is quantified in /J . m^{-3}/.

To verify the influence of mode parameters on the final effect of the mining process, many operational measurements on wheel excavators KU 800 and KU 300 were made. Measurements *in situ* were taken in localities [3;4].

3. Conclusion

Problems discussed in this contribution do not go without extensive measurements made directly on the bucket wheel excavator, and with reference to a large number of input parameters the objectivity of results is usually a subject of careful analyses. The analysis of factors affecting the energy demand of the mining process with bucket wheel excavators proceeds from the latest knowledge in the area of mining by bucket wheel excavators, and on the basis of presented results of our own studies, individual factors are evaluated, the order of their importance is determined, and trends in the next research are proposed.

A priority property characterising the rock – machine interaction is a technological property called *digging resistance*. To be able to fulfil the evaluating and comparing function, this property must be defined by an objective quantity that will enable its quantification [3; 4; 5]. Accepting the quantity of minimum specific energy by volume as a criterion for evaluating the digging resistance made it possible to form a new and more objective opinion on the impacts of particular factors affecting the final effect of the mining process – theoretical efficiency, namely from the point of view of energy demand.

Operational measurements on bucket wheel excavators and their interpretation have proved that the specific energy consumption of the excavator wheel falls:

- with the size of the mined cut, and thus with the mined quantity,
- with a diminishing ratio of cut dimensions, s/b.

In addition, the optimisation of the ratio of cut sides *s/b* has a positive effect on these values. Thus, what is a decisive factor for economical mining is a human factor that at present influences the dimensions of the cut mined without objective information on the breaking process, and thus influences the efficiency and energy demand of mining.

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Omówienie

Artykuł jest rezultatem badań, jakie wykonano w ramach grantu GAČR 105/02/1091 prowadzonego w Republice Czeskiej. Dotyczy on optymalnego wykorzystania mocy zainstalowanej w układzie urabiania koparek kołowych. Określono czynniki mające wpływ na pobór energii przez koło czerpakowe oraz na wydajność urabiania. Za podstawę optymalizacji przyjęto kryterium minimalizacji energochłonności urabiania czerpaka koła koparki. Jednostkowa energia urabiania łączy w sobie moc wydatkowaną na urabianie z objętością uzyskanego w tym czasie urobku. W analizie uwzględniono pobór energii przez koło, wydajność urabiania ze względu na geometrię koła, geometrię noży urabiających i rodzaj stosowanego materiału, wymiary skrawanego wióra oraz wydajność teoretyczną koparki. Weryfikację przyjętych założeń oraz zakres wpływu poszczególnych parametrów na końcowy efekt urabiania określono na podstawie pomiarów przemysłowych (kopalnianych) koparek KU 800 i KU 300.