Controlling production of opencast mines equipped with machinery of fixed parameters

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Riadená výroba lomov vabavených strojným zariadením s fixnými parametrami

In the internal and external conditions, there might occur changes, upon the influence of which, the production of a mine has to be reduced to a smaller or greater extent, perhaps even drastically, while, later on, the previous production level has to be reached again. In such cases, the quick response to these changes is a basic requirement.

In case of opencast mines, the manner and the time demand of the reaction depends on the geological conditions, the equipments used and the mining technology applied.

In case of stripping done with one-bucket-wheel excavators and transported by dump cars or trucks, there is no essential technological restriction. The stripping efficiency can be set by proportionally decreasing the number of equipments used, so as to attain the demanded value.

In case of opencast coalmines it is the German, now widely used and most characteristic winning and working technology based on bucket-wheel and bucket-ladder excavators, with belt-conveyors and dirk stackers. The restrictions of these technological systems are greater in number than in case of technology based on one-bucket-wheel excavators, transported by dump cars or trucks. The restriction arises due to the necessary displacement of the belt-conveyor systems and the ensuring of strict geometrical and other conditions for the winning machines and dirk machines while travelling and working. (Dip in longitudinal and transversal direction of the proceeding way and working level, winning block-parameters etc.)

Within given limits, it is, even in case of such rigid systems possible to reduce the stripping efficiency by way of the putting out of action and the dismounting of winning machine, winning machines, machine-chain or machine-chains, respectively. This special interference, however, might unsettle the functioning of the whole technological system. Whichever element of the system is interfered with, it will have its effect on the equipoise of the whole system, so that it will have to be newly restructured.

A further drawback of this solution is the fact that it cannot be accomplished at once, the space requirement and the time demand of the changeover, depending on the technological parameters of the equipments and the technological solution of the applicable additional exploitation. The time demand can be several months or even years, depending on the advancing speed of the opencast mining.

Meanwhile – naturally up to a point of time calculable in advance – the equipments temporarily put out of action have to be kept in running order (ready for operation) and the technological equipoise of the mine, its harmonic advance must continually be ensured. Thus, even if reacting without a delay to the decision made, a more or less short period will be needed for the achievement of the necessary stripping efficiency, which can have a disadvantageous influence on the target aimed at, in view of which, the decision had been made. (Deterioration of the marketing position, increase of the production costs.)

There exists a limit to the production regulation described previously, namely the following condition:

$$\left(\frac{H^* P_1}{P_{SZ}} \le h_1\right) + \left(\frac{H^* P_2}{P_{SZ}} \le h_2\right) + \left(\frac{H^* P_n}{P_{SZ}} \le h_n\right) = H$$

where: H – the thickness of the overburden,
P_i – the stripping performance of the individual (single) machines,
P_{sz} – the total stripping performance required for the given coal production,
h_i – the maximum winning height attainable by the given machine in the given technological system.

The number of the excavators cannot be reduced less than to the measure to be set with the above formula. With less winning machines, the opencast mine cannot be kept working continuously. In case of coal opencast

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mines with more seams or some other geological formation or layers defining and restricting the division of the seam of the winning into working slices, the applying of the method is strongly limited or even impossible.

If the process is to be reversed, that is, if the production is to be increased again, and the stripping performance necessary for it has to be increased up to the original value, a similar space and time demand will present itself because of the repeated restructuring of the technological system.

Much easier to apply than the above described opencast technological system is another known method, the regulation of the efficiency by altering the working order. By applying this solution, the basic working time of the equipments will naturally decrease. From the various working orders ensuring seven workdays per week, a changeover to other working orders, f.i. 6+1 or 5+2 working order systems (6 or 5 workdays, 1 or 2 days if rest) can be adopted. By applying this method, the running time of the bucket-wheel excavators will be proportionately shortened.

This working order equally concerns the operation of all the machines and machine-chains and thus does not interfere with the build-up and operation of the technological system. Its drawback, however, is that all machines and machine-chains have their standstill at one and the same time. Thus, due to the limits of the maintenance capacity, no worth-while maintenance and technical state repair work can be carried out. Anyway, a standstill time of one or two days is only enough for the accomplishment of the minor part of the maintenance work, the major part needing a much more time.

Another, less known manner of adjusting the necessary stripping performance might be the method based on the cyclic operating of machines and machine-chains, quasi as the combination of the afore mentioned two methods. The gist of this method is as follows: the performance needed is set in accordance with the number of machines running simultaneously, while the technological balance can be ensured by regulating the duration of the cycle. The said method is of essential significance in cases where, in consequence of the afore-said reasons, there is no possibility of reducing the number of machines. According to the sense, the more excavators are working in the opencast, the bigger the number of the possible grades of performance.

The maximal duration of the running and standstill of the machines as well as the rotation speed are equally influenced by the fundamental geometric and geologic characteristics of the opencast and the technological parameters of the machines, respectively. The most important parameter among these is the quantity of the waste winnable by the face conveyor in one position.

The longest possible standstill time may not last longer than the time needed for the winning of the block in one position of the face conveyor, because if longer, it would result in a failure of the working area under the inoperative machine in the slice to be won, and would cause a disturbance in the technological system. By reducing the maximum standstill time to half the time needed for the winning of the above mentioned block, the technological conflicts can be safely avoided. (Under the circumstances of the opencast mine Visonta-South this time duration is about one month).

Naturally, this time depends on many factors and is, moreover, highly influenced by the frequency of incidental events (occurrence) hindering the exploitation.

Naturally, the minimal duration of the cycle is one shift, which is not advisable to use because of other advantages listed in the following.

As compared to the method based on the change of the working order, the advantage of the “rotation” method described above is the fact, that not all the machines have their standstill at one and the same time. Consequently, the maintenance work can be done more smoothly. If the duration of the cycle is properly chosen, the major part of the maintenance works can be accomplished without the need of further standstill time. The method makes it even possible to alter the speed of rotation in the course of the year. For the yearly overhauling, when the main pieces of the equipments are being exchanged, the cycles may be merged to ensure the necessary standstill time without any additional loss of time. According to factual information about the maintenance activity accomplished in the Visonta Mine, 80-90% of the necessary overhauling and maintenance work can be accomplished with a standstill time of six days. In these circumstances it is expedient to declare 6 days to be the proper duration of the cycle.

The “rotation method” can be applied also in cases when, though as a result of technical interventions (developments) the efficiency of the machines is increased, still – due to some other cause – there is no possibility to reduce the number of equipments.

Finally, let it be stressed, that I solely examined the technical, exploitation-technological aspects of the special performance regulation. The volume of the lecture does not render it possible to analyse the economic aspects of the theme.

References

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