ISSN: 0975-766X
CODEN: IJPTFI
Available Online through *Research Article*
www.ijptonline.com

TRANSPORTLESSMINING SYSTEMIN DEVELOPING THESUITEOF THREE HORIZONTAL SEAMS CARBONATE ROCKS

Vladimir Viktorovich Ivanov and Sergey Aleksandrovich Sidorenko
Saint Petersburg Mining University, Russia, 199106, Saint Petersburg, Vasilievsky Island, 21 line,2.

Received on 25-10-2016 *Accepted on 02-11-2016*

Abstract

In developing the horizontal layers of minerals overlain by unconsolidated overburden rocks, the most effective is the use of transportless technological mining schemes with the storage of overburden rocks in the inner dump by shiftment in goave using dragline excavators. The features of mining and technical conditions of the development of carbonate rocks horizontal layers, the used transportless development systems and the relevant standard series of stripping and mining excavators limit the maximum possible number of simultaneously developed benches to three mining and three overburden benches.

Keywords: Dragline, careers, transportless technological schemes, goave, carbonate rocks, excavator performance.

Introduction

The carbonate rocks are very widespread among the subsurface rocks of sedimentary origin. These include the rocks in which the carbonate fraction predominates over the non-carbonate components. The main rock-forming carbonate minerals include calcite and dolomite. The carbonate rocks are used in the cement industry, construction, metallurgy and many other industries. Deposits of carbonate rocks usually represent the intermittent occurrence of horizontal layers of minerals, i.e. the alternating frequent alternation of layers of carbonate rocks and overburden layers. These features of occurrence must be considered in the preparation of project documentation and the choice of the main technological equipment for conducting the open development of deposits under consideration. In developing the horizontal layers of minerals overlain by unconsolidated overburden rocks, the most effective is the use of the transportless technological mining schemes with the storage of overburden rocks in the inner dump by shiftment in the career goaveusing single-bucketwalking dragline excavators (Figure 1).The introduction of the transportless technological schemes of the overburden operations control is carried out at horizontal, flat and low-inclined flat-mass mineral deposits [1-2]. The possibilities for this occur after the formation of the goave of a sufficient size to

accommodate the internal dumps [3].The internal dumps are always more preferable than the dumps located outside the perimeter of career field, due to the fact that they allow to create conditions for the almost complete restoration of lands disturbed by open mining operations. The costs for transporting of overburden rocks are reduced by reducing the distance of rocks transportation and reducing the loading on the transport vessels.

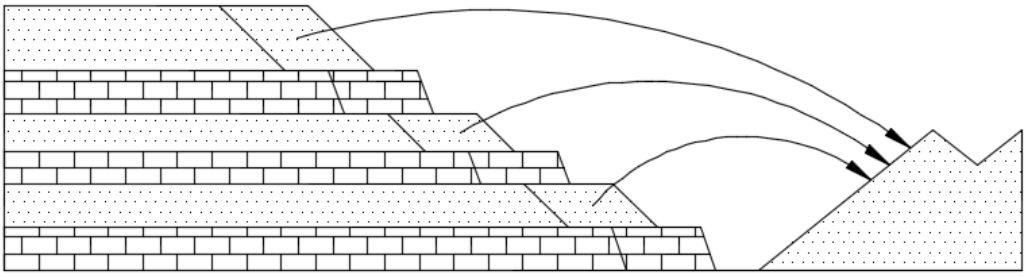

Figure 1: **Conventional geological section of formation of three horizontal layers of carbonate rocks, rocked off with the storage of overburden rocks in the inner dumps.**

The internal dumping according to transportless flows heet with the shiftment of rocks in the goave using excavators helps reducing the cost of transportation of overburden rocks in dumps using career transport means.

The walking dragline excavators are the main cross-loading equipment in mining facilities operating according to transportless scheme [4]. The walking dragline excavators of OJS "Uralmashzavod" are represented in 13 sizes with the bucket capacities ranging from 11 to 100 cu.m, and the boom length from 75 to 130 meters [5].

Compared to the excavator-dumping complex, draglines are less maneuverable, so their use is practiced in the fields with the following characteristics [6]:

- large fields, where a large amount of overburden rocks justifies high capital costs;

- flat dipping deposits ensuring the stability of overburden rock dumps;

- simple geological structure and almost flat terrain predetermining stable power of the overburden thickness over the entire career field;

- deposits with powerful coal seams and the limited capacity of the overburden rocks, since the rational power of the overburden strata using dragline usually has a limit of 60-70 m.

Other geological factors that should be considered in the operation of draglines are the precipitation mode and the air temperature. The humidity of overburden rocks hampers their movement, reduces the stability of slopes of benches and dumps, as well as the stability of benches where the draglines are placed [7].

Many years of experience in operating large walking dragline excavators at mining enterprises of the world testifies to the high efficiency of these machines. The most important of their advantages is not only the possibility to make excavation, but also the delivery of rocks in the bucket directly into the inner dumps due to the large length of the boom. At the same time, the possibility of excavating by upward and downward digging provides for the development of field with the high power of overburden removal and high benches, and low ground pressure during operation and moving allows for the excavator operation at a low bearing capacity of grounds [8].

Materials and Methods

The features of mining and technical conditions of the development of carbonate rocks horizontal layers, the used transportless development systems and the relevant standard series of stripping and mining excavators limit the maximum possible number of simultaneously developed benches to three mining and three overburden benches.

When planning the mining operations at specific horizons, the compliance with the law of a commensurate development of mining on adjacent benches is of great importance [9]. The speed of advancing the front of mining operations on the bench must be greater than or equal to the rate of advancing the front of mining operations on the underlying bench minus the quotient of the excess width of the work area for the period of time required to create equal quantities of worksites on the benches.

Currently, when developing the suite of three horizontal layers of carbonate rocks, the technological schemes are applied using the overburden of overburden rocks and two rock seams of three excavation units for testing, and part of the overburden rocks is stored in external dumps. There exist the methods of open development of flat masses of mineral deposits associated with the running of excavators between the levels, but these methods are associated with a low rate of conducting of overburden mining and the consumption of time to move the excavators.

A well-known one is the system of the development of the suite of three horizontal layers, in which mining operations are simultaneously performed with six benches, three mining with the delivery of minerals to the warehouse or the processing industry, and three overburden with the shiftment of waste rock in the goave [10]. The disadvantage of this development system is the need for a powerful overburden excavator, which simultaneously must work off the bench of first rock seam, the reexcavation loading and the bench of the secondrock seam.

In order to improve the efficiency of mining of the carbonate rocks deposits under consideration represented by a suite of three horizontal layers, a graphic model of the technological scheme was developed for the simultaneous working out of three mining and three overburden benches.

The technology of mining operations on the proposed development system lies in the fact that the first stripping single-bucket walking dragline excavator is located on the roof of the top bench of minerals and by the advancing motion with the upper digging works out the upper overburden bench. At the same time, the same excavator by the departing motion and downward digging works out the first rock layer, revealing a second layer of minerals.

At the same time, the total volume of overburden rock extracted from the array by the first excavator is poured out on the working platforms of lower industrial horizons, subject to the compliance with maximum parameters of the excavator unloading. The second overburden single-bucket walking dragline excavator is on the roof of the second rock seam, and by advancing motion works out the reexcavation bulk formed after the operation of the first excavator, and by the departing motion – the seam between the second and third benches (Figure 2). Mining operations are conducted in the usual way with the transportation of minerals by means of wheeled transport.

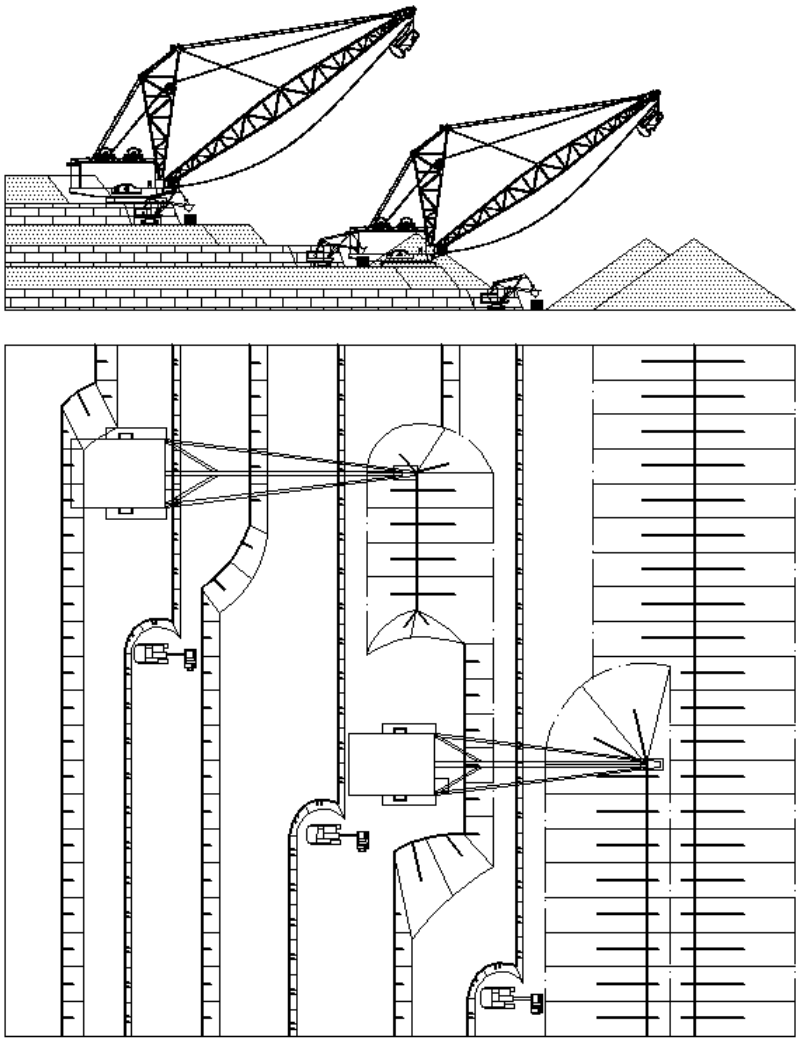

Figure 2: **Transportless mining system in developing the suite of three horizontal seams carbonate rocks.**

The linear dimensions of the top overburden excavator should ensure discharge of overburden rocks on the top platform of the lower bench. The second overburden slope should be located outside the working area of the upper

bench. The performance of the lower overburden excavator should provide for the movement of the full volume of overburden rocks in the inner dump with a given intensity. The working out of overburden rocks and the upper rock seam by the first overburden excavator can reduce the production load on the second overburden excavator, thereby, increasing the scope of this development system taking into account the limited model line of overburden single-bucket walking dragline excavators. The selection of the single-bucket walking dragline excavator shall be based on the following key parameters: digging radius, the maximum possible load on the array, the specific pressure on the soil, the radius of unloading and dimensional radius, the unloading height and the duration of the excavator operating cycle. All parameters depend on the geological conditions of the specific developed mine area [11].

The main parameters and indicators of the functioning of the proposed technological scheme of mining the suite of three horizontal layers of carbonate rocks with the use of single-bucket dragline excavators are the following:

- the height of developed overburden and mining benches;
- the width of the excavation and dump bench widths;
- the length of excavation units;
- the operational performance of excavators.

The height of the bench is one of the main parameters of the technological scheme. When using direct mechanical shovels on the rock excavation and loading the bench height is determined based on the maximum height of the excavator digging. When developing strong half-rocks with the use of drilling and blasting loosening, it may be taken as equal to 1.5 of the digging height, but the height of the debris after the explosion must not exceed the digging height. Unlike direct single-bucket excavators with mechanical cable drive (overburden mechanical shovels), the single-bucket walking dragline excavator is capable of producing the scoop of rocks below the level of its standing. Thus, by placing at the top bench platform or on the planned debris platform after the explosion, the excavator with such equipment can develop the overburden bench with the height equal to its maximum digging depth [12].

In case of transportless technological schemes of mining, the bench width is defined by the operating parameters of excavation and loading unit and the capacity of worked out layers. When using a mechanical overburden shovel the rational maximum bench width corresponds to 1,5 ÷ 1,7 of the excavator digging radius at the level of its state, in order to allow selection of rocks from the goave. The bench width of the single-bucket walking dragline excavator is determined by the maximum excavator digging radius and the angles of its turning relative to the movement path axis, which does not exceed 30-45 degrees.

In the development of design documentation for the open mining of bedded deposits of carbonate rocks, the commercially reasonable lengths of excavation units should be determined for each in-pit transport, taking into account the type of main excavation and loading equipment planned for use. Determining the optimal length of the excavating unit, that is, the scope of work on the bench, falling on one excavator, should be carried out taking into account the maintenance of the set operational performance of the excavator, compliance with all the parameters and indicators of adopted technology of open-pit mining and the lowest costs on mining .

Results and Discussion

The analysis of the results of theoretical and practical studies of settings of conducting open-pit mining, as well as the data of operation of analogue pits working out the deposits of carbonate rocks, by the lengths of worked out overburden fronts of mining operations in the transportless technological scheme of mining of horizontal layers with direct shiftment of overburden rocks in goave, allowed by interpolation to establish rational length of the excavator unit, depending on the power of themined bed of minerals and the models of used single-bucket walking dragline excavators. The results of calculations of the excavator unit length for most common models of single-bucket walking dragline excavators involved in the transportless technological schemes of the carbonate deposits development are shown in Figure 3.

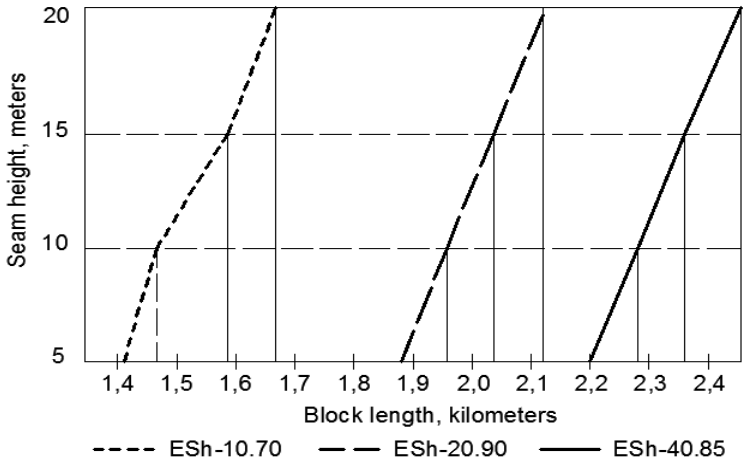

Figure 3: **The graph of the dependence of the excavator unit length for most common models of single-bucket walking dragline excavators involved in the transportless technological schemes of the carbonate deposits development.**

It is useful to determine the operational performance of the excavator in relation to the technological scheme of mining. In general, the natural conditions, technological and organizational solutions affect the performance of the mining machine[13].

The operational performance of the single-bucket walking drag line excavator is directly proportional to the value of down hole performance of the excavator taking into account the length of the maintenance period and the utilization of the excavator during a given period of operation. The down hole performance of the pit dragline depends on many interrelated factors, such as difficulties of the development of the rock mass, which is estimated by the rock category or its strength. For example, in the development of wet shale, which adheres to the bucket, the volume of the last cycle decreases and the cycle duration due to longer bucket unloading increases. In winter conditions, badly crushed frozen ground also reduces the bucket fill factor [14]. The utilization factor of the working excavator time during shift takes into account the inevitable intershift delays caused by its shifting in the mine, the exchange of loaded and empty vehicles near the excavator, the shift transfer and the eliminable organizational downtimes (transport waiting, lack of prepared work front, emergency repairs of the excavator, etc.) [15].

When using single-bucket walking dragline excavators, the frequency of the excavator transposition to the new workplace affects the utilization of the excavator working time during the shift. The process of transposition of single-bucket walking excavator to a new place of work is associated with significant loss of time on preparation, terminating and auxiliary operations, the dragline turning in the transport position, the preparation of the working platform for the new places of the excavator parking, walking process, the equipment placement in the cross face, pulling and placing of feeding high-voltage cable by the excavator operator assistant, etc. Thus, the number of transportations of the single-bucket walking excavator to a new excavation place depends on its operating performance and the performance of the overburden mining enterprise as a whole.

Conclusions

The technological scheme of open pit mining proposed in the paper allows providing for the location of the whole volume of overburden rocks in the inner dump when developing the suite of three horizontal layers of carbonate rocks. Due to the fact that the mining of the entire thickness of coating overburden rocks and waste rock seams is carried out using just two single-bucket walking dragline excavators, the cost of production of carbonate minerals is reduced.

References

1. Gvozdkova, T.N. (2006). Strukturybestransportnykhskhemrazrabotkisvitiztrekhpologikhplastov [Structures Transportless Schemes Developing Suites of Three Flat Seams]. *Bulletin of the Kuzbass State Technical University, 3*, 39-45.

2. Zlobina, E.V., Pronoza,V.G., & Tyulenev, M.A. (2013). K voprosuvy boramodelidraglaynadlyarazrabotkiperspektivnykhugol" nykhmestorozhdeniyKuzbassa[To the Choice of the Model of Dragline for the Working-Out Of Perspective Coal Deposits in Kuzbass]. *Bulletin of the Kuzbass State Technical University*, *6*(100), 41-45.
3. Rakishev, B.R., Moldabaev, S.K., Irgebaev, G.E., &Shulaeva,N.A. (2007). Povyshenieeffektivnostivnedreniyabestransportnykhskhemekskavatsiineodnorodnykhraznoprochnykhporod [Improving the Efficiency of Implementation of Transport Schemes without Excavation of Equally Inhomogeneous Rocks]. *Gornyyinformatsionno-analiticheskiybyulleten',5*, 139-145.
4. Gruzdev, A.V.,&Boyko, G.Kh. (2003). Shagayushchieekskavatorydraglaynyproizvodstvakorporatsii OMZ [Walking Dragline Excavators Manufacturing OMZ Corporation]. *Gornayapromyshlennost', 3*(45), 56-61.
5. Podarni, R.J. (2013). Analizsovremennogosostoyaniyamirovogorynkapostavokvyemochno-pogruzochnogokar'ernogooborudovaniya (mekhlopatyidraglayny) 2 chast'[Analysis of the Modern Open Pit Mining Loading Tools Delivery to the World Market (Power Shovels and Draglines).Part 2]. *Gornayapromyshlennost', 6*(112), 106-111.
6. Westcott, P. (2004). *Dragline or Truck/Shovel? Some Technical and Business Considerations*. University of New South Wales, Mitsubishi Development Pty Ltd.
7. Hughes, D.B., & Leigh, W.J.P. (1985). Stability of Excavations and Spoil Mounds in Relation to Opencast Coal Mining.*Quarry Management, 12*(4).
8. Gruzdev, A.V., &Sandrigaylo, I.N. (2008). Shagayushchiedraglayny [Walking Draglines]. *Gornayapromyshlennost', 5*(81), 6-8.
9. Arsentiev, A.I. (2010). *Razrabotkamestorozhdeniytverdykhpoleznykhiskopaemykhotkrytymsposobom* [The Development of Solid Mineral Deposits by Opencast Mining]. Saint Petersburg.
10. Ivanov, V.V., Sidorenko, S.A., Sidorenko, A.A. &, Korzhavykh,P.V. (2014). The Prospects of Introduction of Surface Miners in Technology of Development of Deposits of Contiguous Seams of the Limestone. *Advances in Environmental Biology, 8*(13), 298-300.
11. Scott, B., Ranjtih, P.G., Choi, S.K., &Khandelwal, M.(2010). A Review on Existing Opencast Coal Mining Methods within Australia. *Journal of Mining Science, 3*, 73-88.

12. Fedotenko, V.S. (2012). Vyborkompleksovgornogoitransportnogooborudovaniyadly arazrabotkivysokogovskryshnogoustupa [The Choice of Complexes of Mining and Transportation Equipment for Working of High Overburden Bench]. *Bulletin of the Kuzbass State Technical University, 2*(90), 31-36.
13. Dudinsky, F.V. (2013). Metodicheskieosnovyopredeleniyaparametrovtekhnologiivskryshnykhrabot s formirovaniemvneshnikhotvalovdraglaynami [Methodological Bases to Determine Technology Parameters of Stripping Operations with Draglines Forming External Dumps]. *Bulletin of Irkutsk State Technical Universit, 12*(83), 149-153.
14. Poderni, R.Yu.,Bocharov, R.A., &Kholikov,M.S. (2010). Vliyaniekinematicheskikhisilovy khparametrovprivodovrabochegooborudovaniyadraglaynana ego proizvoditel'nost' [Influence of Kinematic and Power Parameters of Drives of theWorking Equipment Dredge on Its Productivity]. *Ugol', 11*, 35-37.
15. Egurnov, G.P.&Reysh, A.K. (1969). *Odnokovshovyeekskavatory* [Power Shovels]. Moscow: Nedra.