N E W S
OF THE NATIONAL ACADEMY OF SCIENCES OF THE REPUBLIC OF KAZAKHSTAN
SERIES OF GEOLOGY AND TECHNICAL SCIENCES
ISSN 2224-5278
Volume 4, Number 442 (2020), 127 – 137 **https://doi.org/10.32014/2020.2518-170X.93**

UDC 622.271: (622.682+622.684)
IRSTI 52.13.17

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INFLUENCE OF AN INSTALLATION ANGLE OF THE CONVEYOR LIFT ON THE VOLUMES OF MINING AND PREPARING WORK AT QUARRIES AT THE CYCLIC-FLOW TECHNOLOGY OF ORE MINING

Abstract. Determination of the effect of the installation parameters of the conveyor hoist on the volumes of mining operations in the open-pit mine at cyclic-flow method for the ore mining. Justification of application of various technological schemes of cyclic-flow method (CFM) depending on the duration of work at the concentration horizon of crushing and loading points, as well as rational schemes of opening the open-pit mine.

To achieve the purpose of this paper we have used the integrated approach, including the analysis of scientific papers to identify problematic aspects of the applicability of the cyclic-flow method in domestic open-pit mines, the analytical studies to identify the relationship between the volumes of mining operations and the technological parameters for mining the open-pit fields, the method of technical and economic comparison to justify rational schemes for opening the open-pit fields.

We have scientifically established the areas of expedient application of steeply inclined conveyors in the technological CFM schemes in comparison with usual belt conveyors which are expedient to use at a height of rock mass hoisting of 100-200 m and more and at an annual output of 5-10 million tons.

We have determined the areas of preferable application of steeply inclined conveyors in the technological CFM schemes in comparison with usual belt conveyors. It is expedient to use the steeply inclined conveyors in the CFM complexes with an annual output 5-10 million tons at a height of rock mass hoisting of 100-200 m and more. When increasing the volumes of movement by the CFM complexes up to 20-30 million tons per year, it is expedient to use the steeply inclined conveyors at a height of rock mass hoisting of 200-300 m and more. In these conditions, with practically equal operating costs, the specific capital costs of the CFM complexes with steeply inclined conveyors are lower by 6-20 %.

As a result of technical and economic calculations, we have confirmed high efficiency of application of technological schemes with steeply inclined conveyor hoisting and semistationary crushing and loading devices at open-pit mines with high annual output. The results are useful for the organizations engineering the mining enterprises with open pit mining.

Key words: cyclical-flow technology, deep quarries, mobile crushing and reloading plants, concentration horizon, mining preparatory work.

Introduction. Problems and its connection with scientific and practical tasks. Application of the cyclical-and-flow method (CFM) in conditions of constant deepening of open-pit mines allows to reach high concentration of operations, to improve indicators of use of mining transport equipment, to provide high degree of automation of technological processes and to increase work efficiency of the open-pit mine as a whole.

In recent years, the use of the CFM in open-pit mines as energy-and resource-saving mining technologies continues to be relevant. A sufficient number of publications have been devoted to the questions of possibility and expediency of using and development of the CFM complexes at the open-pit mines [1-8], as well as to the problem of increasing the output through the use of rational design and layout schemes of the CFM complex elements, reducing the costs of the CFM complexes by reducing the number of dump trucks in the cyclical link of the CFM.

The performed studies have showed that specific energy consumption of the cyclic-flow method used in the open-pit mines of the Commonwealth of Independent States is lower by 14-16 % compared to the cyclic technology. Distribution of energy consumption by the main technological CFM processes is on average the following: transportation of rock mass 75-80 %, crushing 8-10 %, excavation 16-18 % [9,21].

However, the possibilities of the cyclic-flow method used in the open-pit mines of the Commonwealth of Independent States have not been fully realized. The main disadvantages of the applied CFM schemes include the stationary nature of crushing and conveyor complexes, whose use contradicts the dynamics of mining operations (rate of progress in depth being 7-15 m/year) and the conditions for the formation of technological cargo flows. The stationary nature of the CFM facilities determines the large volume of capital mining and construction and installation works (up to 75 % of the total cost of the complexes) and, as a result, the construction time for such complexes is at least 3-5 years. The service life of the crushing and loading point at one concentration horizon is at least 8-10 years. This determines the irrational working conditions of gathering vehicles: the actual distance of transportation of the rock mass at the site from the excavator face to the crushing and loading point (CLP) reaches 3 km or more. The rate of progress in depth and the lengthening of the inclined conveyor result in considerable "throwing" costs connected with liquidation of the earlier operating CLP as its stationary nature allows to dismantle for the further use only a mechanical part (crusher and feeders) that makes no more than 28 % of the total CLP cost.

Analysis of previous studies and publications on the problem. The conditions for the formation of the working area of the deep open-pit mines and the space-time distribution of the rock mass volumes necessitate the use of such crushing and loading devices (CLD) in the technological CMM schemes, whose design ensures their periodic movement in the open-pit space as the open-pit mine deepens. Such the CLDs, which provide high flexibility of the method in changing the mining conditions of the lower horizons of deep open-pit mines, include the semistationary crushing and loading devices of block-modular design with output of 600, 1000 and 1350 m^3/h (up to 6-12 million tons of ore per year). The choice of the CLD type, the frequency and the step of its transfer are established on the basis of the results of optimization of technological cargo flows over a long mining period. The most effective use of the CLDs is in combination with open-type belt conveyors with an angle of inclination from 15-16° to 35-45° [10-11].

Scientific works of academician of RAS N. N. Mel'nikov and M. S. Chetverik were devoted to the problems of opening the deep horizons of the open-pit mines and locating the CLPs at concentration horizons. However, at present there is no verified and proven system of opening schemes with justification of the CLD operation term at concentration horizons before its subsequent moving to the lower horizon [12-14].

In addition to the considered technical solutions aimed at improving the efficiency of the CMM through the use of more advanced and mobile equipment, the correct location of the crushing and loading device at the concentration horizon and the scheme of opening the concentration horizons are essential.

When locating the belt conveyor hoists in the open-pit mines (trenches and semitrenches) at the open pit walls with the crushing and conveying complexes currently in operation, the crushing and loading devices are adjoined directly to the hoists. Such location of these units and their sites have required the mining and preparation works related to the spread of the open pit walls and the excavation of additional volume of overburden, or keeping the permanent pillars of rocks. Additional mining operations have led to an increase in the volume of overburden excavation in the open-pit mine, and a part of the project volume of mineral extraction has been kept in permanent pillars of rocks.

The analysis of the methods for formation of sites for the crushing and loading devices of the CFM at the iron ore open-pit mines of Ukraine has shown that when using the cone crusher KKD-1500 at the stationary CLP and locating the belt conveyor hoist in the trench the sizes of the site for the CLP are large. They vary from 210×100 m in the Poltavskiy open-pit mine to 360×260 m in the Annovskiy open-pit mine at the Severny MPS. When opening the horizons for locating such the points by inclined shafts, the sizes of sites change from 180×160 m at the open-pit mine 2-bis of the Novo-Krivorozhskiy MPS to 480×280 m at the open-pit mine of the Yuzhny MPS. When locating the conveyor hoist in the inclined shaft and crosscuts, the size of the sites varies from 100×70 m at the Inguletskiy open-pit mine to 200×140 m at the Pervomayskiy open-pit mine of the Severny MPS. Table 1 shows the volumes of overburden excavation during the mining operations for the CLD site with the size of 200×100 m depending on the depth of its laying at the open pit wall.

Table 1 – Overburden excavation volumes for the crushing and loading device site

Depth of laying of the CLD site, m	Volume of overburden excavation for the CLD site, mln. m^3	
	With preliminary spread of the final open pit wall	At permanent pillar of rocks in open-pit mine outline
100	3.4	2.0
200	9.6	4.0
300	18.6	6.0
400	30.4	8.0
500	40.5	10.0

To open the horizons of the CLD location at the iron-ore open-pit mines of Ukraine, a scheme was widely used with the installation of a conveyor hoist in inclined shaft and crosscuts located beyond the final outline of the open-pit mine. Crosscuts open up the horizons of the location of the CLD. The conveyors move rock mass by the crosscuts from the crushing and loading devices located at the temporary pillars of rocks (temporary nonworking sites of working open pit wall), with reloading to the stationary conveyor in the inclined shaft. With the rate of progress in depth, the inclined shaft and the conveyor hoist in it are lengthened and new crosscut is extended with the installation of the conveyor in it to new concentration horizon and new CLP is built at the temporary pillar of rocks. The old CLP is dismantled and the pillar is developed under it. Such system of opening the concentration horizons meets the requirements of blast works in the open-pit mine. Significant disadvantages of this opening system are the high cost of underground mines and the long construction time of the CFM facilities. This does not allow to fully realize the advantages of the CFM and significantly reduces its competitiveness. The cost of opening excavations for installation of the belt conveyor hoists in them is several times less than the cost of construction of underground excavations for installation of hoists. But the open location of the hoists will be effective only when there is no need to excavate large additional volumes of overburden from the spread of the open pit wall in order to form the base of the conveyor excavation at the final open pit wall. When using the known methods of construction of the mine gallery with the hoist the base of the conveyor excavation locates also a strip with sites for the installation of the construction crane and a road for the movement of the tractor trolley, which delivers the construction components of the gallery and the hoist equipment to the site of installation, and to move the crane from site to site. At the Annovskiy open-pit mine of the Severny MPS of Ukraine the width of the base of the semitrench formed at an angle of 15° for a gallery 9.4 m wide is 36 m. The gallery locates two belt conveyor hoists with a belt width of 2000 mm. In addition to the gallery with hoists, the base of the semitrench includes a strip with sites for the construction crane and a road for the tractor trolley. The formation of such a base of the semitrench down to a depth of 154 m with a site for loading between the conveyor lines has required the spread of the final open pit wall with the excavation of additional overburden with a volume of 3.5 million m^3.

Study methodology. The studies have been carried out using an integrated approach, including the analysis of scientific works to identify the problematic aspects of the applicability of cyclical-and-flow method in domestic open-pit mines. Analytical studies allowed to reveal interrelationships between the volumes of mining operations and the technological parameters of development of the open-pit fields. Rational schemes for opening the open-pit fields are justified by the method of technical and economic comparison.

For calculations the following initial data have been accepted: angle of inclination of the conveyor hoist being 16°, angle of inclination of the open pit wall in final position being 37°. The output of the crushing and conveying complex is 18 million tons per year. The costs for the conveyor track were determined for a depth of 120, 240, 360 and 480 m [15-16].

The semitrench and trench forms of excavation for the belt conveyor hoist differ from each other in that the part of the base of the semitrench in width is located on an inclined safety berm, replacing sections of the horizontal safety berms of the open-pit mine along the hoist route. The semitrench can only be formed on a straight section of the open pit wall. On the open pit wall, which includes convex and concave sections, there can be formed an excavation for a belt conveyor, which, in order to excavate the minimum volume of overburden, includes the trench and semi-trench sections.

Figure 1 shows the dependences of the volumes of the spread of the open pit wall for the trench on the width of its base for the belt conveyor hoist with a belt width of 2000 mm, being obtained by analytical methods and graphical modeling. It is shown that with increasing the width of the trench base from 15 to 40 meters the volume of mining operations with depth increases from 4 to 10 million m^3.

Figure 2 shows the dependence of the volume on the spread of the open pit wall for the trench for the belt conveyor hoist (1) and the reduced costs for the conveyor track when locating the conveyor hoist in the trench and inclined shaft and crosscuts.

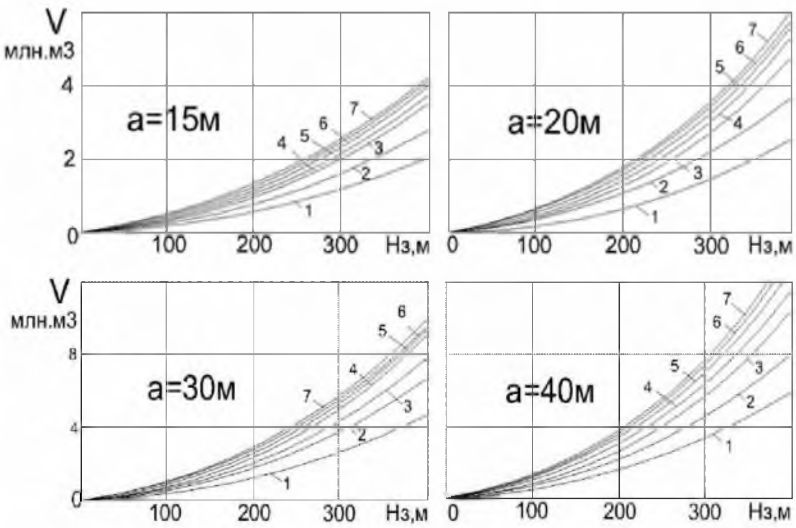

Figure 1 – Dependence of the volume of mining operations for the trench of the belt conveyor hoist (V) on the depth of its laying (Нз) with different width of the base of the trench (a) and inclination angles of the open pit wall: 1 - 20°; 2 - 25°; 3 - 30°; 4 - 35°; 5 - 40°; 6 - 45°; 7 -50°

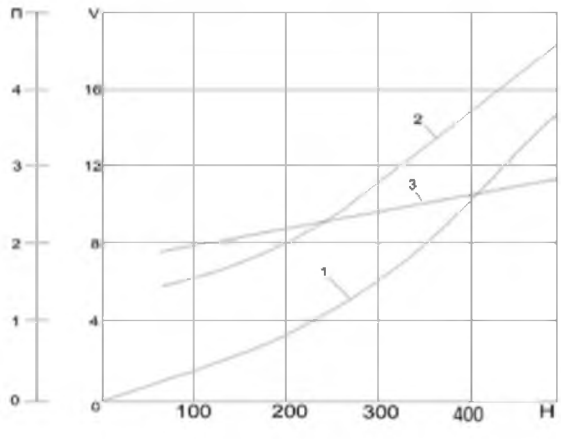

Figure 2 – Dependences of the volume on the spread of the open pit wall (V, mln. m^3) for the trench for the belt conveyor hoist (1) and the reduced costs for the conveyor track (P, mln. rubles) when locating the hoist in the trench (2) and the inclined shaft and crosscuts (3) from the depth of the trench (H, m)

It follows from an analysis of the diagrams that it is more advantageous to locate the belt conveyor hoist down to a depth of 250 m in the trench. At greater depth of trenching the costs for the conveyor hoisting essentially increase in comparison with the costs at locating the hoists in underground excavations. The main reason for the increase in costs is the increase with the depth of the additional volume of the overburden excavation from the spread of the open pit wall for the trench. At lower angle of inclination of the open pit wall in the final position, the volume of the spread for the trench at the same depth of its laying will be smaller, and the rational area of use of the belt hoist with its location in the trench by the depth of the open-pit mine increases. Hence it is possible to draw a conclusion that the area of application of the trenches (semitrenches), for locating the belt conveyor hoists and construction and transport communications in them and in the open-pit mines developing steep deposits is opening of the first concentration horizons by depth of the open-pit mines. With this method of construction of the conveyor hoists in the galleries at the final open pit walls, opening the next in depth concentration horizons by the inclined shafts put down behind the final outlines of the open-pit mines and the crosscuts from the shaft for the crushers of the crushing and loading points in the open-pit mine will be economically more profitable. However, with this location of the conveyor hoist the costs of the crushing and conveying complex will be very high.

In order to reduce the volume of the mining operations for the trench of the internal belt conveyor hoist, part of the trench base by its width can be located at the inclined safety berm, replacing the horizontal safety berm sections along the hoist route. In this case, the opening excavation takes the form of the semitrench. The wall excavation width for the semitrench compared to the trench is reduced by the width of the safety berm of the open-pit mine. Table 2 shows the volumes of overburden excavation during the mining and capital works for the trench and semitrench of the belt conveyor hoist at the final open pit wall. Accepted: the angle of inclination of the open pit wall is 35^{o}, the width of the base of the mine is 30 m and the angle of inclination is 16^{o}.

Table 2 – Volumes of mining and capital works for opening excavations of belt conveyor hoist

Depth of pit, m	Overburden excavation volume, mln. m^3	
	for trench	for semitrench
100	0.64	0.40
200	2.13	1.41
300	4.80	3.03
400	8.11	5.27
500	12.53	8.12

Results and discussions. The established analytical dependencies for determining the volume of mining operations for the trench of the conveyor hoist have allowed to establish that when laying the trench with the base width of 30 m down to a depth of 240-400 m, these volumes will be from 2 to 10 mln. m^3 with a change of inclination angle of the open pit wall from 20^{o} to 50^{o}.

On the basis of graphic modeling of opening excavations it is established that on a straight line section of open pit wall the smallest volume of mining operations is provided when locating the conveyor hoist in the semitrench. Part of the base of the semitrench in its width is an inclined safety berm, replacing parts of the horizontal safety berm along the hoist route. The width of the spread of the open pit wall in comparison with the trench decreases by the width of the safety berm of the open-pit mine.

When locating the belt conveyor hoist in the opening excavation at the final open pit wall, the rational technological scheme of a crushing and conveyor complex corresponds to the technological scheme of a complex with locating the hoist in the inclined shaft and cross cuts. According to this scheme, the conveyor hoist at the final open pit wall is connected to the crushing and loading points in the temporary pillars of rocks through the transfer conveyors. Their length corresponds to the safe distance to the conveyor hoist according to the condition of blast works . In addition to the possibility of developing the temporary pillars of rocks under the crushing and loading points, another advantage of such a scheme, in comparison with locating the crushing and loading points at the final open pit walls, is the reduction in the distance of transportation by gathering vehicles. Dump trucks enter the unloading sites directly from the working area of the open-pit mine, bypassing the final open pit wall.

The rational scheme of opening when locating the belt conveyor hoist at the final open pit wall can be realized only with a single-wall mining system. Only in this case, the stationary and transfer conveyors can be located at the final open pit wall, and the crushing and transfer points can be located in the temporary pillars of the working open pit wall. Locating the crushing and loading points in the temporary pillars of rocks excludes additional overburden from mining operations for the sites of these points, as opposed to locating them in sections of the final open pit wall.

The main reason for the large volumes of overburden for the opening excavation of the belt conveyor hoist is the method of constructing a gallery with a hoist, which requires the formation of a construction and transport communication on the basis of the excavation, including the sites for the installation of the construction crane and the road for its movement and movement of the tractor trolley with cargo. The Institute of Mining of the Ural Branch of RAS has developed the methods of construction of conveyor hoists at the final open pit wall, which allows to reduce the volume of mining operations from the spread of the open pit wall. They are based on the principle of combining the conveyor and the construction and transport communications with the horizontal and inclined safety berms of the open-pit mine. When using one of these methods, the construction and transport communication is located on a temporary rock fill, and the conveyor hoist being located in the semitrench, which is an inclined safety berm of the open-pit mine. After the construction of the gallery with the hoist, the temporary rock fill is levelled simultaneously with setting the working benches of the open-pit mine to the final outline. It is established that there is a possibility to build the belt conveyor hoist without the spread of the open pit wall when locating the construction and transport communications at the inclined safety berm of the open-pit mine and the conveyor hoist in the gallery on supports above the side slopes of the semitrench. In another method, the construction and transport communication and the conveyor hoist are located at the adjacent inclined safety berms of the open-pit mine, being separated by the bench slope.

The belt conveyor hoist consists of individual conveyors, between which the transfer units being arranged. In order to build and maintain the conveyor lines, the vehicle mounts should be arranged from the main ramp in the open-pit mine to the sites of transfer units. The mounts require the preliminary mining operations with the spread of the open pit wall or keeping the permanent pillars of rocks. Additional mounts can be excluded if the routes of the hoist and the main ramp are linked to each other in such a way that the sites of transfer units between the conveyor lines are connected to the turn sites of the ramp.

The main direction for improvement of crushing and conveyor complexes in open-pit mines is the use of mobile crushing and loading points instead of stationary crushing and loading devices [17-19]. Moving the mobile crushing and loading device (MCLD) as the operations in the open-pit mine develop and its location at the deeper horizons allows to reduce the distance for transportation of rock mass by the gathering vehicles. Moving the MCLD along the stationary belt conveyor hoist is not rational, because of the need to form permanent sites at the final open pit wall to move it with the excavation of additional volume of overburden. For the effective use of the MCLD, the temporary belt hoisting conveyor can be used to be located in the excavation, which is a combination of the trench and the semitrench. The excavation is formed at the temporary pillar of rocks by the border of working and final open pit walls. The rock mass is transferred from this conveyor to the transfer conveyor located at the final open pit wall to the stationary conveyor hoist. The installation is adjacent directly to the temporary conveyor, and it will be moved along it with the rate of progress in depth, reducing the transportation distance by the gathering vehicles (figure 3).

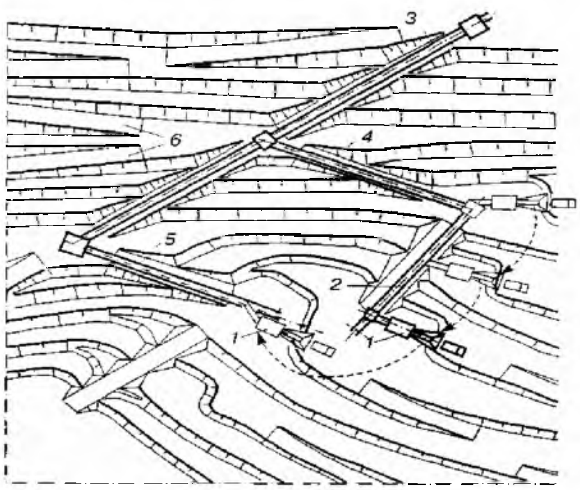

Figure 3 – Crushing and conveyor complex at open pit wall: 1 — MCLD; 2 — temporary hoisting conveyor; 3 — stationary conveyor hoist; 4, 5 — transfer conveyors; 6 — main vehicle ramp

If it is necessary to extract the rock mass from all the open-pit mine horizons, which are crossed by the hoisting conveyor along which the MCLD is moved, it is rational to use several units of lower output instead of one unit of high output. They are spread in height along the conveyor. When loading the belt hoisting conveyor at several points, the lower part of the conveyor belt will be always not fully loaded. In this case, a conveyor system can be used, which consists of several smaller conveyors with different outputs and lengths, installed one above the other and loaded by different MCLD located at different depths of the open-pit wall. Such an installation allows to reduce the metal consumption of the conveyor hoist and the volume of rock mass spilled from the idle flight of the conveyor belt.

The results of comparing the volumes of mining and capital works at the installation of belt conveyors in underground and opening excavations with the installation of a steeply inclined conveyor (SIC) allow to make a conclusion about the undeniable advantages of the latter. The systems of cyclic-flow method with use of steeply inclined belt conveyors and semistationary crushing and loading devices of block-modular design providing fast installation and dismantling of the complexes meet the most requirements of development of deep open-pit mines. Technical and economic calculations and data on foreign firms indicate high efficiency and prospects of the CFM systems with the SIC. One of the main conclusions that can be drawn from the experience of the SIC in the Muruntauskiy open-pit mine for 8 years, with an annual output of 18 million tons of ore is the operation of a unique facility installed at the open pit wall without any mining and capital works, except for the installation of the SIC supports on the concrete base [20].

When using the SIC, it is possible to create any (including complex) configuration of conveyor line routes with a minimum number of loading devices. The SICs allow to locate them at angles of the slope of the open pit walls and to combine inclined sections of the conveyor line with flat sections without loading devices. The angle of inclination of the conveyor line can be changed along the route length up to 90°. All this allows to transport the rock mass by the shortest distances, having essentially reduced the length of the conveyor lines in comparison with traditional conveyors, and to minimize the mining and capital works, having refused to lay special trenches and shaft sinking in open-pit mines [21].

Conclusions. The studies in the Institute of Mining of Ural Branch of RAS have determined the areas of preferable application of steeply inclined conveyors in the technological CFM schemes in comparison with usual belt conveyors. It is expedient to use the steeply inclined conveyors in the CFM complexes with an annual output 5-10 million tons at a height of rock mass hoisting of 100-200 m and more. In these conditions, with lower (down to 15-20 %) costs, the specific capital costs of the CFM complexes with steeply inclined conveyors are significantly (by 6-20 %) lower. When increasing the volumes of movement by the CFM complexes up to 20-30 million tons per year, it is expedient to use the steeply inclined conveyors at a height of rock mass hoisting of 200-300 m and more. In these conditions, with practically equal operating costs, the specific capital costs of the CFM complexes with steeply inclined conveyors are lower by 6-20 %.

2. Application of the scheme of opening the concentration horizons for locating the CLP, providing the maximum co-locating of the CLD sites with the temporary nonworking sites of open pit walls, and the bases of conveyor excavations, the construction sites and the mounts to them with the inclined and horizontal safety berms will reduce the volume of mining operations.

3. On the basis of graphic modeling of opening excavations it is established that on a straight line section of open pit wall the smallest volume of mining operations is provided when locating the conveyor hoist in the semitrench.

4. When choosing a scheme for opening and developing the deep horizons for open-pit mines at the CFM, it is necessary to take into account the costs of additional overburden from the spread of the open pit wall for a steep trench and the unloading sites of the CLP.

5. In the future, the development of cyclic-flow method in deep open-pit mines should be based on the use of steeply inclined conveyors installed on concrete supports, which will significantly reduce the volume of mining operations as well as reduce construction time and increase the efficiency of the CFM as a whole.

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ҮЗІЛМЕЛІ-ТОЛАССЫЗ ТЕХНОЛОГИЯ АРҚЫЛЫ КЕН ҚАЗУДА КОНВЕЙЕРЛІ КӨТЕРГІ ОРНАТУ БҰРЫШЫНЫҢ АРШЫҚТАГЫ ТАУ-КЕН ДАЯРЛАУ ЖҰМЫС КӨЛЕМІНЕ ӘСЕРІ

Аннотация. Зерттеу мақсаты – кен өндірудің циклдік-ағынды технологиясы кезінде аршықтағы тау-кен дайындау жұмыстарының көлеміне конвейерлік көтергішті орнату параметрлерінің әсерін анықтау. Ашық қазу жұмысы тереңдету жағдайында ұдайы үзілмелі-толассыз технология пайдалануы, өндірістің жоғары деңгейде шоғырлануына, тау-кен тасымалдау жабдықтарының пайдалану көрсеткіштерін жоғарылатуға мүмкіндік береді, технологиялық үдерістердің жоғары автоматтандыру дәрежесін қамтамасыз ету арқылы және жалпы аршық жұмысының тиімділігін жоғарылатады.

Жүзеге асырылған зерттеу нәтижелері бойынша ТМД елдерінің үзілмелі-толассыз технология пайдаланатын аршықтарда үлесті энергия қолдану мөлшері үзілмелі технология пайдаланатын аршықтардан 14-16%-ға төмен көрсеткішті байқатты. Үзілмелі-толассыз технологияның негізгі технологиялық үдерістеріне келетін энергия қолдану мөлшері келісідей: кен массасын тасымалдауға 75-80%, ұсатуға 8-10%, экскава-циялауға 16-18%.

Зерттеу нәтижесінде құрастырылған график бойынша аршық тереңдігі 250 м-ден терең болмаса конвейерлі көтерғіні траншеяда орналастыру тиімділігі аңықталды. Аршық тереңдеген сайын ордың ұзындығы мен тау-кен даярлау жұмыстарының көлемі де артады. Шығынның ұлғаюының негізгі себебі – траншеяға карьер бортын таратудан аршылған жыныстарды қазудың қосымша көлемінің тереңдігі арқылы өсу. Аршықтың тереңдігіне сәйкес карьер бортының еңкіш бұрышы азайтылған шамада болған жағдайда және сол тереңдікке сәйкес орды үңгілеу үшін қажетті көлем де азаяды, ал аршықтың тереңдеуіне сәйкес конвейерлі көтерғіні қолдану мүмкіндігі жоғарылайды.

Iшкі салынған таспалы конвейерлік көтерғіштің траншея астындағы тау-кен-дайындық жұмыстарының көлемін азайту мақсатында траншея негізінің бір бөлігі оның ені бойынша көтерғіштің трассасымен көлденең сақтандырғыш бермалардың учаскелерін ауыстыратын көлбеу сақтандырғыш бермада орналасуы мүмкін. Бұл жағдайда ашу кен қазба нішіні жартылай траншеяға ұқсас болады. Аршық жағдайын жартылай траншеяның орналасу жағдайын қамтамасыз ететін шамаға жылжыту траншея орналасуымен салыстырғанда ол аршықтың сақтандырғыш алаңының еніне тең мөлшерге азаяды.

Тік еңкішті конвейерлерді қолдану қайта тиеу қондырғылар санын азайтуға және кез келген пішіндеме мен және орнату бұрыш бойынша конвейерлерді пайдалану мүмкіндігін береді. Тік еңкішті конвейерлерді аршық жағдайының еңкіш бұрышы бойынша орнатуға мүмкіндік береді, сонымен қатар конвейерлі трассаларының жайпақ және көлбеу бөліктерін қайта тиеу қондырғыларсыз тіркестіреуге жағдай тудырады.

Конвейерлі көтергінің еңкею бұрышын трассаның ұзындығы бойынша 90°-қа дейін өзгертуге болады. Мұның бәрі конвейерлер желісінің ұзындығын әдеттегі конвейерлермен салыстырғанда ең қысқа қашықтық бойынша кен массасын тасымалдауға мүмкіндік береді және траншея мен оқпанды үңгілемей-ақ тау-кен күрделі жұмыс көлемі күрт азаяды.

Ұсату-қайта тиеу қондырғыларының жинақтаушы көкжиекте жұмыс ұзақтығына байланысты үзілмелі-толассыз технологияның түрлі технология тәсімдерін қолдануды негіздеу және аршықтың тиімді ашу тәсімін дәлелдеу.

Әдістеме. Қойылған мақсатқа жету үшін жұмыста ғылыми еңбектерді талдауды қоса алғанда аршықтарда үзілмелі-толассыз технология қолданудың өзекті мәселелерін айқындау, аналитикалық зерттеулер тау-кен даярлау жұмысының көлемі мен аршық қазудың технологиялық параметрлерінің өзара байланысын анықтау, техника-экономикалық салыстыру әдістемесі – аршық алаңдарын тиімді ашу тәсілін дәлелдеу барысында кешенді әдіс қолданылды.

Нәтижелер. Үзілмелі-толассыз технология тәсімдерінде тік еңкішті конвейерлерді қолданудың ғылыми бағыттары әдеттегі таспалы конвейерлермен салыстырылып негізделген, оларды кен массасының көтеру биіктігі 100-200 м немесе одан жоғары болғанда және аршықтың жылдық өнімділігі 5-10 млн.т. болған жағдайда қолданған жөн.

Ғылыми жаналығы. Тік еңкішті конвейерлі үзілмелі-толассыз технология тәсімдерін әдеттегі таспалы конвейерлермен салыстырғанда олардың артықшылығын пайдалану аймағы анықталды. Жылдық өнімділігі 5-10 млн.т. үзілмелі-толассыз технологиялық кешенде тік еңкішті конвейерлерді кен массасының көтеру биіктігі 100-200 м-ге тең не одан жоғары болғанда қолданған тиімді. Үзілмелі-толассыз технологиямен тасымалданатын көлем жылына 20-30 млн.т.-дан жоғары болған жағдайда, ал көтеру биіктігі 200-300 м немесе

одан жогары болғанда тік еңкішті конвейерлерді қолдану тиімділігі жогарылайды. Бұл жағдайда пайдалану шығын көлемі тең болганда тік еңкішті конвейерлерлі үзілмелі-толассыз технология кешендерінің үлесті күрделі шығыны 6-20%-га төмен болады.

Тәжірибелік мацыздылығы. Жылдық өнімділігі жогары аршықтарда техникалық-экономикалық есептеу нәтижесінде құрамында жылжымалы ұсату-қайта тиеу құрылгылармен жабдықталган тік еңкішті конвейерлерлі технологиялық тәсімдерінің жогары қолдану тиімділігі дәлелденген. Нәтижелер ашық тәсілмен кен қазатын тау-кен кәсіпорындарын жобалайтын мекемелерге пайдалы болады.

Түйін сөздер: үзілмелі-толассыз технология, терең аршық мобильді ұсақтау және қайта-тиеу қондыргылары, тік еңкішті конвейер, жинақтаушы көкжиек, тау-кен даярлау жұмысы.

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ВЛИЯНИЕ УГЛА УСТАНОВКИ КОНВЕЙЕРНОГО ПОДЪЁМНИКА НА ОБЪЁМЫ ГОРНО-ПОДГОТОВИТЕЛЬНЫХ РАБОТ НА КАРЬЕРАХ ПРИ ЦИКЛИЧНО-ПОТОЧНОЙ ТЕХНОЛОГИИ ДОБЫЧИ РУД

Аннотация. Целью исследования является устанавление влияния параметров установки конвейерного подъёмника на объёмы горно-подготовительных работ в карьере при циклично-поточной технологии добычи руд. Применение циклично-поточной технологии в условиях постоянного углубления открытых разработок позволяет достичь высокой концентрации производства, улучшить показатели использования горно-транспортного оборудования, обеспечить высокую степень автоматизации технологических процессов и повысить эффективность работы карьера в целом.

Выполненные исследования показали, что удельное энергопотребление применяемой на карьерах СНГ циклично-поточной технологии по сравнению с цикличной технологией ниже на 14-16%. Распределение энергопотребления по основным технологическим процессам ЦПТ в среднем составляет: транспортирование горной массы 75-80 %, дробление 8-10 %, экскавация 16-18 %.

Из анализа графиков исследований следует, что до глубины 250 м ленточный конвейерный подъемник более выгодно размещать в траншее. При большей глубине заложения траншеи затраты на конвейерный подъём резко возрастают. Основной причиной увеличения затрат является возрастание с глубиной дополнительного объема выемки вскрышных пород от разноса борта карьера под траншею. При меньшем угле наклона борта карьера в конечном положении объем разноса под траншею при одной и той же глубине ее заложения будет меньше и рациональная область использования ленточного подъемника с его размещением в траншее по глубине карьера увеличивается.

С целью уменьшения объёма горно-подготовительных работ под траншею ленточного конвейерного подъёмника внутреннего заложения часть основания траншеи по его ширине может быть расположена на наклонной предохранительной берме, заменяющей по трассе подъёмника участки горизонтальных предохранительных берм. В этом случае вскрывающая выработка приобретает форму полутраншеи. Ширина разноса борта под полутраншеею в сравнении с траншеей уменьшается на ширину предохранительной бермы карьера.

При применении КНК открывается возможность создания любой, в том числе сложной конфигурации трасс конвейерных линий с минимальным количеством перегрузочных устройств. КНК позволяют располагать их под углами откосов бортов карьеров и сочетать наклонные участки конвейерной трассы с пологими участками без перегрузочных устройств. Угол наклона конвейерной линии может изменяться по длине трассы вплоть до 90°. Все это позволяет транспортировать горную массу по кратчайшим расстояниям, существенно сократив длину конвейерных линий по сравнению с традиционными конвейерами, и свести до минимума горно-капитальные работы, отказавшись от прокладки на карьерах специальных траншей и проходки стволов.

Обоснование применения различных технологических схем циклично-поточной технологии в зависимости от продолжительности работы на концентрационном горизонте дробильно-перегрузочных пунктов, а также рациональных схем вскрытия карьера.

Методика. Для достижения поставленной цели в работе использован комплексный подход, включающий анализ научных трудов – для выявления проблемных аспектов применимости циклично-поточной технологии на карьерах, аналитические исследования – для выявления взаимосвязи объемов горно-подготовительных работ и технологических параметров разработки карьеров, метод технико-экономического сравнения – для обоснования рациональных схем вскрытия карьерных полей.

Результаты. Научно обоснованы области целесообразного применения в технологических схемах ЦПТ крутонаклонных конвейеров в сравнении с обычными ленточными конвейерами, которые целесообразно использовать при высоте подъема горной массы 100-200 м и более и годовой производительности 5-10 млн. т.

Научная новизна. Установлены области предпочтительного применения в технологических схемах ЦПТ крутонаклонных конвейеров в сравнении с обычными ленточными конвейерами. В комплексах ЦПТ с годовой производительностью 5-10 млн. т. крутонаклонные конвейеры целесообразно использовать при высоте подъема горной массы 100-200 м и более. С увеличением объемов перемещения комплексами ЦПТ до 20-30 млн. т в год крутонаклонные конвейеры целесообразно применять при подъеме горной массы на высоту 200-300 м и более. В этих условиях при практически равных эксплуатационных расходах, удельные капитальные затраты на комплексы ЦПТ с крутонаклонными конвейерами ниже на 6-20 %.

Практическая значимость. В результате проведенных технико-экономических расчётов подтверждена высокая эффективность применения технологических схем с крутонаклонным конвейерным подъёмом и полустационарными дробильно-перегрузочными устройствами на карьерах с большой годовой производительностью. Результаты являются полезными для организаций, проектирующие горные предприятия с открытым способом разработки.

Ключевые слова: циклично-поточная технология, глубокие карьеры, мобильные дробильно-перегрузочные установки, концентрационный горизонт, горно-подготовительные работы.

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