Код МРНТИ 52.13.15

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IMPROVEMENT OF CYCLIC-FLOW TECHNOLOGY FOR DEPOSITS WITH LOW ORE CONTENT AND HIGH PRODUCTIVITY

Abstract. The cyclic-flow technology for low-grade deposits is one of the most important components of the industry. In this article the authors analyzed, how improvements in cyclic-flow technologies can be facilitated to meet the required performance and performance expectations in an unpredictable future. It is a mechanism that ensures progress in the right direction in terms of reducing mining costs and significant achievements in environmental management. The traditional three approaches are the exact type of crushing plant, the optimal mining and handling equipment, and the well conveyor. The new fully mobile crushing system is a great improvement over the original three options, which can ultimately ensure the necessary improvements in the cyclic-flow technology for low-grade and high-productivity deposits. Which in turn gives significant growth in regarding the economic context. Many companies strive to find effective technology for increasing income.

Key words: *cyclo-flow technology, low-grade deposits, technology improvement, crushing plant, productivity, environment, cost reduction, production.*

Кен мөлшері төмен және өнімділігі жоғары кен орындары үшін ағындық циклды технологияны жетілдіру

Аңдатпа. Төмен сортты шөгінділерге арналған циклдік ағын технологиясы саланың маңызды құрамдас бөліктерінің бірі болып табылады. Бұл мақалада авторлар болжанбайтын болашақта қажетті өнімділік пен күтілетін нәтижелерге қол жеткізу үшін циклдік ағынды технологияларды жақсартуға қалай үлес қосуға болатынын талдады. Бұл тау-кен шығындарын азайту және қоршаған ортаны басқарудағы маңызды жетістіктер тұрғысынан дұрыс бағытта ілгерілеуді қамтамасыз ететін механизм. Дәстүрлі үш тәсіл қолданыста, олар: ұнтақтау қондырғысының нақты түрі, оңтайлы тау-кен жабдықтары және ұңғыма конвейері. Жаңа толық жылжымалы ұсақтау қондырғысы бастапқы үш нұсқадан айтарлықтай жақсарту болып табылады, бұл сайып келгенде төмен сортты және жоғары өнімді кен орындары үшін циклдік ұнтақтау технологиясында қажетті жақсартуларды қамтамасыз ете алады. Бұл өз кезегінде экономикалық контекстке қатысты айтарлықтай өсім береді. Көптеген компаниялар кірісті арттырудың тиімді технологиясын табуға тырысады.

Түйінді сөздер: *ағындық цикл технологиясы, төмен сортты кен орындары, технологияны жетілдіру, ұсақтау қондырғысы, өнімділік, қоршаған орта, шығындарды азайту, өндіру.*

Усовершенствование циклично-поточной технологии для месторождений с низким содержанием руды и высокой производительностью

Аннотация. Циклично-поточная технология для бедных месторождений является одним из важнейших компонентов. В статье проанализированы способы совершенствования циклично-поточной технологии для достижения требуемой производительности, снижения затрат на добычу полезных ископаемых, а также обеспечения охраны окружающей среды. Традиционно используются три составляющие: точный тип дробильной установки, оптимальное горно-погрузочное оборудование и скважинный конвейер. Новая мобильная дробильная установка является значительным улучшением по сравнению с первоначальными вариантами, что, в конечном итоге, может обеспечить необходимые усовершенствования в технологии циклического измельчения для низкосортных и высокопродуктивных месторождений. Это, в свою очередь, даст значительный экономический рост.

Ключевые слова: *циклично-поточная технология, низкосортные месторождения, совершенствование технологии, дробильная установка, производительность, окружающая среда, снижение затрат, добыча.*

Introduction

The mining industry is structured so that drilling and blasting operations have become some of the most important components in recent years. The volumes of exploding rocks have been growing continuously, thus increasing the demand for technologies that can accelerate the mining processes, adhere to the cost considerations and facilitate environmental management in the best ways possible. Cyclic-flow technology for deposits characterized by low ore content and high productivity has emerged as one of the ideal ways of addressing various concerns in the mining processes and the industry at large. In this context, the emphasis is on analyzing how improvements can be facilitated in cyclic technologies to meet the required performance and efficiency expectations moving into the unforeseeable future.

Background Analysis

The use of cyclic-flow technology schemes characterized by mobile crushing and reloading complexes in the context of open cast mining has been in practice in recent years. A comprehensive analysis of the cyclic-flow technology schemes comprising the mobile crushing schemes and reloading complexes that have continued being used in open cast mining indicates various aspects of the radical improvement associated with it. These include the creation, development, and implementation of the new mining transport equipment facilitated by the quarry's technological schemes [1].

Such aspects entail the mobile excavators crushing and the transshipment plants on top of the conveyor systems. Technological schemes for the development of rocks facilitated by the end arrangement of the mobile complexes that use the single bucket excavator and conveyor transport have been facilitated [2, 3]. They are continuously enhanced by the utilization of mobile complexes and the increased width linked to the working platform in the wake of transportation.

There is also the presence of the mobile interstage loading crane that is equipped with sequential mining at three horizons. It is a situation that has paved the way for the methodology linked to determining the working time and the aspect of the annual productivity associated with mobile crushing and handling conveyor complexes [4] The understanding in that regard is that in the context of the open-pit mining associated with the mineral deposits of uniform strength and diverse aspects of the contents, it becomes instrumental in relying on the use of the technological frameworks that adhere to the needs of performance and efficiency at any given moment.

Current Alternatives

At the moment, it is documented that there are three distinct frameworks of cyclic-flow technology for deposits characterized by low ore content and high productivity.

They differ in terms of the types of machinery and installations used. Moreover, some differences are linked to their location in the face based on the utilization aspects.

The First Option

The option is associated with the installation of the mobile crusher in the face, as depicted in figure 1 [5], where the rock has to be loaded into the crusher by the excavator operating via the hopper feeder that functions as an integral part of the whole system. The crushed ore downhole conveyor has to be moved directly to the intermediate or the main conveyor. It can be noted that the notable weakness associated with this approach is that there has to be a focus on fencing the conveyors on the lower sides during the blasting and the systemic movements.

Second Option

The approach focuses on installing the mobile conveyor-reloader between the downhole conveyor and the mobile crusher, as captured in figure 2 [5]. It will be realized that the mineral ore is usually loaded into the crusher by using the excavator via the hopper feeder. The mineral ore from the crushing plant is eventually transferred to the mobile conveyor-reloader before it is further taken to the downhole conveyor [6]. The understanding in that regard is that the stated technology allows the mining professionals to reduce the movements of the downhole conveyor in a move that ensures that they are placed at a great distance away from the bottom.

Third Option

The whole approach is usually based on using mobile crushers located at the working site, as captured in figure 3 [5]. The understanding is that the single-bucket wheel loaders undertake coordinated activities that include extraction, loading, and delivery of the mineral ore mass to the crusher.

It is an approach in which the movement of the crusher and that of the conveyor are established as being less frequent than in the case of the first and second approaches. Moreover, the distance associated with the delivery of the ore from the bottom using the single-bucket loader becomes instrumental in determining the movement steps.

Analysis of the scientific literature based on the studies undertaken by [7] it is stipulated that the emphasis is laid on the presentation of the basic methods associated with the development of the deposits by using the mobile crushing complexes. The implication is that moving forward, there is the need to focus on establishing an efficient technological scheme for such endeavors. Moreover, the effectiveness and rationality of using the cyclic-flow technological schemes that rely on the mobile crushing-reloading-conveyor complexes (MCRCC) have to be based on specific mining and geological conditions.

Similarly, whenever the mining experts and management teams determine that the use of mobile crushing complexes has to be considered, it becomes necessary to predict the efficiency linked to the mining endeavors. Moreover, it also becomes essential to consider the reliability of the equipment complex and the exceedingly necessary aspect of the environmental effects of such comprehensive and technologically enhanced mining processes[1]. The implication in that regard is that whenever the decision-makers pronounce themselves on the way forward concerning the use of the cyclic-flow technologies that are based on the mobile crushing complexes, [8] point out that it is incumbent upon them to work in a manner that will ensure the scientific substantiation and systematization of the mining schemes.

Methodological Framework

Choices have to be made concerning the optimal technological approaches that have to be used within the realms of the MCRCC framework. Various conditions have to be made in the decision-making endeavors. First, a choice has to be made on the exact type of crushing plant that has to be used, given the attainment of the maximum

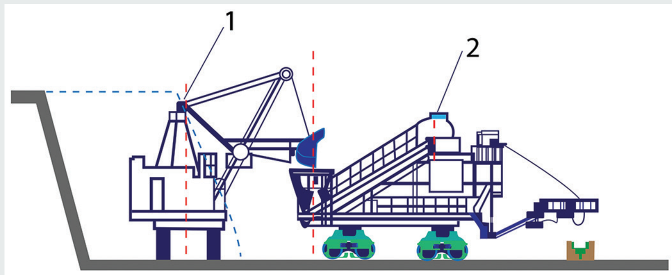

Figure 1. The first option with the installation of the mobile crusher in the face.
Сурет 1. Бірінші нұсқа кенжарға орнатылған мобильді ұсатқышты.
Рис. 1. Первый вариант с установкой мобильной дробилки в забое.

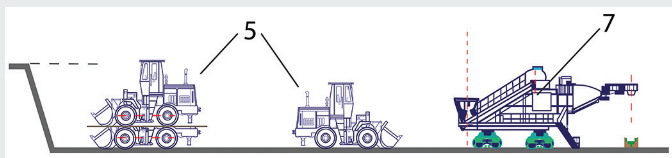

Figure 2. The second approach on installing the mobile conveyor-reloader between the downhole conveyor and the mobile crusher.
Сурет 2. Ұңғыма конвейері мен жылжымалы ұсатқыш арасында жылжымалы конвейерді қайта жүктеуді орнатудың екінші тәсілі.
Рис. 2. Второй подход по установке мобильного конвейера-перегружателя между скважинным конвейером и мобильной дробилкой.

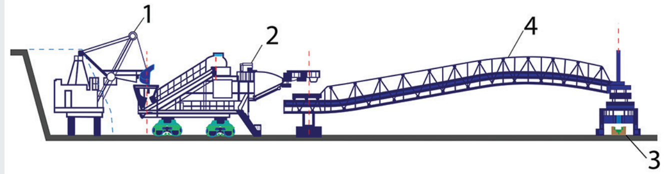

Figure 3. The third approach based on using mobile crushers located at the working site.
Сурет 3. Үшінші тәсіл жұмыс алаңында орналасқан жылжымалы ұсатқыштарды қолдануға негізделген.
Рис. 3. Третий подход основан на использовании мобильных дробилок, расположенных на рабочей площадке.

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[1] Khokhryakov B.C. Open pit design. – Moscow: Nedra, 1992. 383 p. (in Russian)

productivity of the excavator. Moreover, the required lumpiness of the mineral ore associated with the various mechanical and physical properties has to be explored.

The second necessary aspect is to select the optimal mining and handling equipment that aligns with the expected technological parameters. Some of the leading parameters that must be considered are the capacity associated with the excavator bucket, discharge height, and the mechanism of loading into the crusher hopper. It is closely followed by the third condition of considering the presence and types of the re-loaders.

The third expectation and condition that has to be observed in the context of the comprehensive MCRCC framework is the selection of the downhole conveyor that can either be telescopic or mobile based on the prevailing circumstances and preferences. The fourth consideration is based on the choice of the installation method that has to be linked to the crushing plant in the loading process and other related aspects. Lastly, the emphasis must be placed on selecting the installation methods and moving the aspect of the inter-step loading crane.

Comparative Analysis

Decisions have continued being made by the mining engineers and the management teams of the various mining companies concerning the right versions of the three approaches of the cyclic-flow technology aspects that have to be used at any given moment. A comparative analysis of the three approaches commonly used in the current dispensation is facilitated by the data captured in the graph (figure 4) [5].

The graphic information above indicates that all three versions of cyclic-flow technology schemes are associated with the increase in length of the block, as is the case from 200 m to 1800 m. It is associated with increased annual productivity from 3.5 to 5.8 cubic meters per year. It is displayed in the graph that the system performances associated with the first and the second approaches/options have almost similar values.

It is evident in the second option that the increase in the extent of the length of the block from the initial 500 meters leads to a reduction in the levels of performance as compared to the case of the first option of the cyclic-flow technological scheme. In the case of the third option, it is evident that the system's performance is comparatively faster with the small block length. The increase in the length of the same block from a figure in the region of 700 m led to rapid instances of increases.

The implication in that regard is that the low performance of the system in the context of the length that is up to 700 meters can be related to the reasoning that the third option of the cyclic-flow technological scheme is associated with the larger number of idle transfers of the complex. It is a situation larger than observed in the first and second approaches/options, respectively.

Based on the observations made in the case above, the implication is that there has been a focus on the development of the methodology whose rationale is to ensure the determination of the two aspects. They include the annual productivity and working time associated with the MCRCC framework that has to be compared to the three approaches/options of cyclic-flow technological schemes that have been reviewed. The emphasis, in that case, has to be laid on the need to establish the dependence of the annual productivity associated with the block length of the MCRCC framework [9].

Alternative Approach/Option

The prospect of improving the cyclic-flow technology for deposits with low ore content and high productivity calls for the need to implement a proven effective and efficient framework based on past performance levels. A comparison of the three options of the cyclic-flow technological schemes that have been considered in this context reveals that there is the need to formulate a comprehensively new technological approach linked to the MCRCC framework that will be relied upon to ensure the provision of the high system performance while ensuring low time spent on idling.

The need to have a system that adheres to the above requirements paves the way for the formulation of the new technological framework characterized by the development of the overburdened ledges equipped with the central heating system necessary for the deposits with low ore content and high productivity based on MCRCC. It, therefore, follows that such a comprehensive and efficient system is recommended moving forward. The figure 5 [5] illustrates the necessary framework.

A concise overview of the new system indicates that it is organized and structured in ways that work on two horizons. According to [10], the implication is that the downhole conveyor has to be installed on the upper ledge for efficiency purposes. The development of the new MCRCC framework

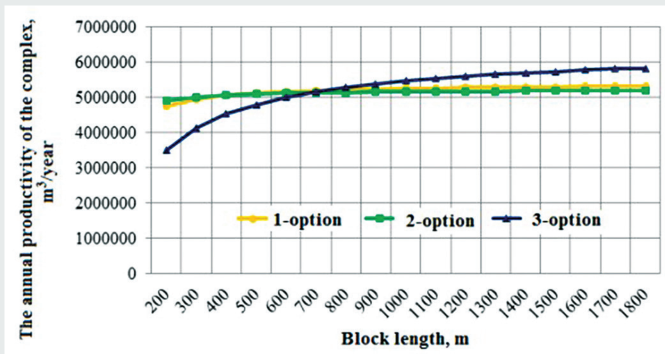

Figure 4. Three versions of cyclic-flow technology schemes are associated with the increase in length of the block.
Сурет 4. Циклдік ағындық технологиялық схемалардың үш нұсқасы блок ұзындығының ұлғаюымен байланысты.
Рис. 4. Три варианта технологических схем с циклическим потоком связаны с увеличением длины блока.

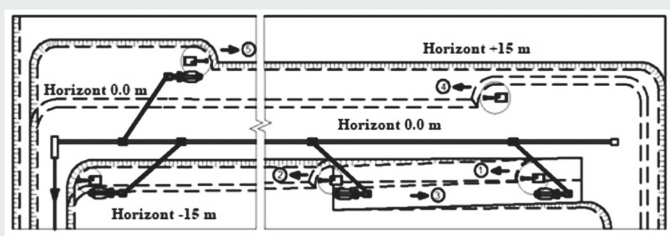

Figure 5. The necessary framework.
Сурет 5. Қажетті шектеулер.
Рис. 5. Необходимые рамки.

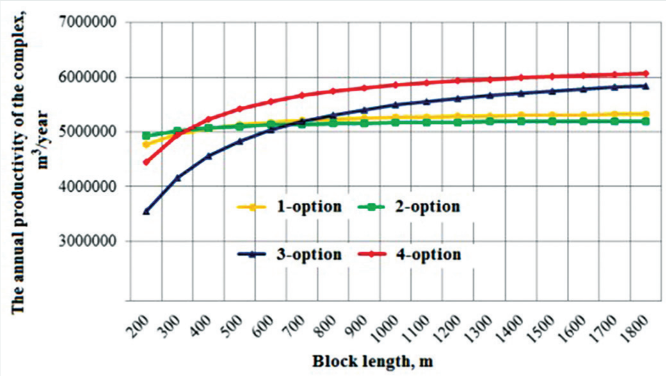

Figure 6. The performances of the new MCRCC framework tend to increase with the length of the block.
Сурет 6. Жаңа жылжымалы ұсақтау-қайта тиеу-конвейерлік кешендердің өнімділігі блок ұзындығымен ұлғаяды.
Рис. 6. Производительность новых мобильных дробильно-перегрузочно-конвейерных комплексов имеет тенденцию к увеличению с увеличением длины блока.

leads to the need to compare it with the previous three approaches/options that have always been at the disposal of mining engineers and executives (figure 6) [5].

The data above indicate that the performances of the new MCRCC framework tend to increase with the length of the block. The situation is linked to the decreases in the number of cycles observed during the working period around the year. It can also be noted that studies have established that the productivity of the MCRCC tends to increase with the decrease associated with the specific time of the movement of the downhole conveyor in the regular working cycle [8].

It is a situation that calls for comparing the new cyclic-flow technological approach to the previous ones. In the new dispensation, there is increased productivity based on the increase in the length of the block. It has to be noted that the whole analysis is on deposits with low ore content and high productivity, where productivity is of great essence. The approach of working out benches based on the longitudinal runs by the system that has the lateral location linked to the downhole conveyor and the availability of the mobile interstage loading crane that has been facilitated by the sequential mining operations occurring at two horizons has been responsible for the high levels of productivity.

Conclusion

The prospect of improving cyclic-flow technology for deposits with low ore content and high productivity calls for adopting the technological scheme to ensure the required outcomes. In this context, three approaches that have been greatly used in the past have been explored, where it has been established that they fail to attain the required performance levels. At that juncture, a new mechanism based on the MCRCC complex had to be formulated. Analysis of the new approach has led to the understanding that it is way better than its predecessors regarding high productivity and environmental management concerns.

The novelty associated with the new approach of the cyclic-flow technological scheme based on the MCRCC complex implies the need for more empirical studies to ensure further improvements. The notable aspect of the new approach/option is based on the movement of the complex that follows the excavator, which guarantees the flexibility and mobility of the entire mining and transport system. It is a mechanism that ensures progress in the right direction. It is associated with a reduction in mining costs and significant success in environmental management. The new fully mobile crushing system is a great improvement on the initial three approaches/options that can finally guarantee the required levels of improvement of cyclic-flow technology for deposits with low ore content and high productivity.

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