

A Concept of Refine Mining in Open-Pit Mine Production: An Introduction

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Abstract - As the global economy and social development raises, population, resources and the environment become the three major topics in today's social development worldwide. Global resources faces huge test. Today, mining tends to adopt a more wasteful model which is the extensive mining mode, and it is still used due to improper early exploitation, high price of mining and environmental governance which will cause great damage and great waste of resources. To reasonably use the resources by eliminating the possibility of waste quickest, optimize the production process, reduce time investment, shorten operation cycle time, minimization of production cost and the sharp recovery of ecological environment are the objectives here. Refine management integrated with the use of rock mechanics and other multidisciplinary theories, combine methods of domestic scholars on fine mining and open pit mining theory to analyze the open-pit mine exploitation were used to develop new theory and methods for refine open pit mining. We can say that fine mining is indeed a continuous way of achieving higher and improved mining procedures. Fine mining can improve the system structure, personnel organization, operation mode, market supply and demand. New mode of fine mining can achieve best results to enhance economic, environmental and social benefits.

Keywords: *Fine Mining, Global Resource, Open Pit, Mine Production, Management, Environment.*

I. INTRODUCTION

From time in memorial, mining has played an important part in human existence. The history of mining is fascinating. It equals the history of civilization with many important cultural eras associated with and identified by various minerals or their derivatives: the Stone Age (prior to 4000), the Bronze Age (4000 to 5000), the Iron Age (1500 to 1780), the Steel Age (1780 to 1945), and the Nuclear Age (1945 to the present) [1]. Till date, the abundance of minerals plays an important role in providing a method of creating wealth in many countries that have them. Minerals can be sold on the open market, thus enabling these countries to obtain valuable currency from countries that don't have [3]. The ability to use mineral resources as a means of creating wealth opens the possibility that a given country or countries will attempt to control the entire market in a particular

mineral, that is, to create an economic cartel in that mineral [2]. Unfortunately, as the need for modernized construction in mining industry, population, resources and environment problems become more and more prominent. The situation of resource shortages will accompany the whole process of industrialization in our world due to reasons such as politics, history, economy and technology of abandoned mines in transit. In such mines, using the traditional methods is difficult to achieve the purpose of safe and efficient recycling of mineral resources; thus, the concept of refined mining arises at this historic moment.

With the progress of science and technology, social division of labor and specialization, more and more industries put forward the concept of fine management and fine production. For example, fine agriculture integrates remote sensing, geographic information system, global positioning system (GPS), computer technology, automation technology and new technology all in agricultural production [16]. Also protection of agricultural ecological environment is realized to sustain development [4]. More so, automobile industry has also experienced great change from extensive production to the development path of fine production and has been greatly successful. Due to particularity of production environment and the uncertainty of safety, fine mining should involve a wider range of science, technology and management issues. In this light, the open-pit mine refinement would be an important direction of mining development in 21st century and which definitely will promote the transformation from extensive mining to a new form of technicalization and modernization which is the bases of my research.

II. LITERATURE REVIEW

A. *Theory and concept of surface mining*

Based on the concept of fine production and according to the characteristics of the fine mining production plan, then fine mining is to be integrated by application of drilling, blasting, machinery, electronics, automation and other aspects of advanced technology [11]. Comprehensively, considering the various problems in mining such as mining damage to the environment, ore transport work, minimize

waste stone removing content, supporting work, which mainly includes: in-depth knowledge of mining objectives, combination of one or more mining method, careful construction, strict design, safety of personnel, equipment, improving the process of fine production and fine production management, and the use of best mine safety conditions will all be achieved. The main economic benefit, environmental benefit and social benefit will also be gained.

Fine production is put forward due to the shortage of resources. Fine production (lean production) concept originated from Japanese Toyota Company [13] and fine production can be summarized as spend less resource, maximize utilization of resource, solving the problems of shortage of resources and meet the constantly changing consumer demand. In fine open-pit mining, open pit mining environment achieves destruction, mine rock transport function and the amount of slope excavation and maintenance workload are all minimized. The author-patented technology¹ is one of the core experts of the open pit fine mining [15]. At the same time, it is needed to take full advantage of the mining system engineering, mining and environmental engineering, restoration ecology, theory and methods, in-depth study of the soil and water conservation engineering, botany, computer science, management science, and other aspects of internal relations of the open-pit mining process proposed by new optimization. Also, combine processes such as shortening the operating cycle time and restoration of the ecological environment at shortest possible time to achieve the purpose of significantly reducing production costs and protecting the environment are some of the key factors [8].

¹ "quick exhaust of soil slope protection and ecological restoration of open pit mining process (Patent No.: ZL 2006 1 0019707.2).

Unlike underground mining, surface mining is done in open outdoor environment with the operation of engineering technology by using certain mining transportation equipment's. Surface mining is divided into the open pit slope of open-pit mine and concave open pit mine [5]. Mining levels above open-pit mining boundary closed circle is called the slopes of open-pit mine and mining level below the open-pit mining boundary closed circle is called concave open pit mine. When the buried depth of ore body is relatively shallow or surface outcrop, the application of strip mining is most appropriate. Compared to underground mining, open pit is full of resource utilization, high recovery rate and low dilution rate. They are suitable for large mechanical construction, fast building, large output, high labor productivity, low cost, good working conditions and safety in production [5].

B. Main production process

These are the four basic processes of open pit mining, which are interconnected with each other. Reciprocated control will influence the production and development of open-pit mine throughout the whole process of open-pit mine production.

1) The ore bearing rocks disintegration

Using methods such as blasting or machinery to loose and break ore bearing on the bench is suitable for mining equipment. As on the bench, mining equipment's can directly excavate the ore-bearing rock properly and safely.

2) Loading

Is a process done through excavating equipment. Loading of the ore and the surrounding rock loose pieces on the bench is done and put into transport equipment. The process is an important link of mine production.

3) Transportation

By automobile, locomotive, transportation equipment such as belt conveyor and so on, will be used to transport ore from the mines to the designated place. Sometimes is from the ore to the concentrator of transport or store of the mines, and waste rocks to the spoil bank.

4) Unloading

Ore-bearing rocks, after transported to the designated place are then unloaded.

C. The fine open-pit mining guiding ideology [12]

The fine open-pit mining concept proposes a number of new optimization combined processes in a way that promotes the shortening on the ecological damages, allow a quick restoration of the environment and shortens the time to achieve the purpose of the production by significantly reducing the costs.

1) Open-pit mining system and process research

Open-pit mining is a complex system, while excavation of mineral resources continues to damage the surrounding ecological environment causing desertification, landslides, mudslides and other geological disasters. To this end, the human exploitation of mineral resources and environmental protection must be coordinated. The system contains a number of interrelated subsystems which must be from the point of view of the system, the use of operations research theory to study each step of the process, optimize them, shorten the operating cycle time with the lowest cost of mining the ore and to achieve the purpose of protecting the environment in the best way possible.

2) Slope maintenance theory and technology research

After the formation of the final slope in the role of production blasting and weathering, the strength and stability of the slope over time gradually decreases. Therefore, research should be done as much as possible to shorten the process of the final slope of the survival time. The steep slope angle should be appropriate thereby reducing the stripping ratio and slope maintenance workload, avoiding geological disasters and reducing production costs.

3) *Slope materials and methods*

There are many ways for conventional open pit unstable slope control, like cut the top of the hill and pressurize the foot of the slope and so on. For the mines which have the conditions for emission of stripping waste rock mined in open pit, waste rock slope is used as protection material, expelling waste rock inwards which is also mainly used as Slope protection methods. Traditional "Pressure the foot of the slope" is updated into "Pressurize waist" and "pressurize chest" to eliminate the possibility of invading the final slope slumping and finally reaching the purpose of permanent slope control.

4) *Open-pit mining stratigraphic disturbance destruction minimized*

Change the traditional large-scale advanced stripping and mining in the production process to meet the requirements of the principle, thereby stripping and mining in the smallest possible range. Once the scope of mining is completed rapidly, the range of reclamation and environmental control will restore the environment and ecology.

5) *The material transport function minimization study*

Open-pit mining waste rock and ore are transported in large amount. Stripping waste rock pit emissions should be as much as possible near the dump press slope. The use of operations research and other methods to minimize the total transportation of ore and rock power are also implemented.

III. FINE OPEN-PIT MINING PROCESS

Fine open-pit mining technology: has within row to strip mine waste rock conditions at one end or the middle of the open pit using conventional method which is the initial stripping and mining. Once you have completed the initial stripping, mining and advance deposit mining direction, the mining face is then divided into left to help area, the right to help area and further divided into a number of smaller segments. Mining segmentally unit-by-unit gradually carrying out stripping, mining, press slope backfilling and reclamation or concrete cover is done. Final slope permanent control means lower production costs and quick restoration of the ecology to strip waste rocks near emission pressure slope [12,14].

Figure 1. The formation of Initial stripping surface [14]

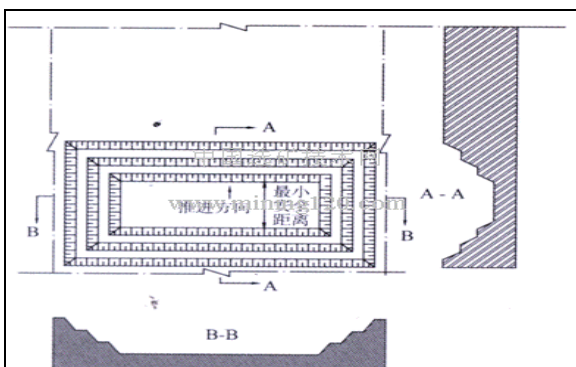
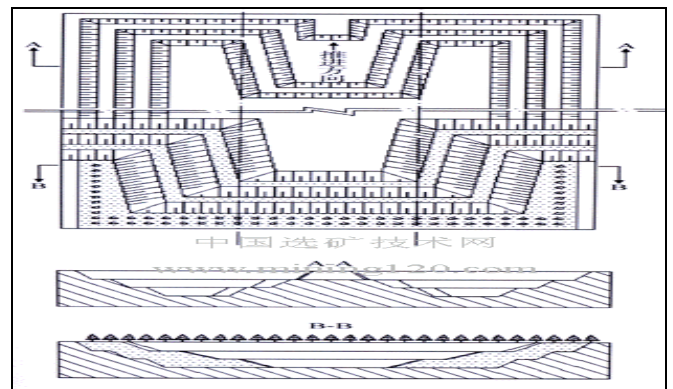


Figure 2. Dump and slope expansion and eco-system recovery [14]



A. *These are the steps of the process:*

- 1) For mining the ore body, waste rock should be stripped at one end or the middle part of the ore body with conventional methods and discharged into waste-dump. The minimum size initial stripping working face should satisfy the technological requirements (Fig. 1).
- 2) In direction of stripping propulsion, stripping area is divided into left side, middle side and the right side to meet the need for the smallest size and the best technical and economic indicators of the stripping operation (Fig. 2). Each area is divided into a number of segments.
- 3) The first segment of stripping and mining at the left and right are followed by the first segment of stripping and mining at the middle and in the pit the goaf i.e. mining the waste left in old mines. The internal emissions are critical with the aim to permanently control the slope for the rear side of the open pit.
- 4) For the final slope segments of permanent control, reclamation and afforestation or coverage with concrete and restoration of ecology should be carried out as soon as possible.
- 5) The second step is carried out which is the second segment of stripping and mining of both the right and left. Waste rock is used for the first segment slope revetment backfill with stripping and mining in the middle appropriately following-up and stripping waste rock for it's nearest backfill. The segments with reclamation should be immediately greened or covered with concrete for ecosystem restoration.
- 6) From the end of second step and into the normal production cycle, segmentation advances until mining is complete and ecological restoration is completed.

From mining of the deposit in the middle of the formation of the initial stripping face, two stripping face can be formed using the above process of reverse propulsion.

IV. ADVANTAGES AND DISADVANTAGES OF REFINE OPEN-PIT MINING.

The knowledge of mining information system plays a core role, which is to promote mining from "extensive" to "intensive" as the core of its strength, as a result, not only effectively improving the mining efficiency but also the operation and management level. Fine production is summarized as spend less resource to maximize resource

utilization and fine production. The fine management idea has become increasingly vital in managerial places in all walks of life along with the advancement of society especially the social development and economic production mode from extensive to intensive, which makes "fine" more and more important. As mineral resources is a foundation for human survival and development resources, its exploration and production must pursue a sustainable mode of production which fine mining is doing. It creates reasonable use of resources, eliminating the possibility of waste as soon as possible; optimizing the production process, reducing the time of investment etc. Fine open-pit mining elaborates on the mining technology so as to meet shorten operation cycle time, minimization of production cost and the sharp recovery of ecological environment [12-17].

Presently, domestic ore mining models have also been given different ideas and opinions. However, as the concept of mine refinement is in its infancy, there are only few scholars in the research and analysis of fine mining. An Incomplete statistics of the fine mining theory is one of the demerits. Due to particularity of production environment and the uncertainty of safety, fine mining should involve a wider range of science, technology and management issues. Britain, Canada, Australia, Russia and other countries have established the information system in mines. Although the set up of system function is not perfect yet, it opens the introduction of counting machine mining application information technology [12-14].

VI. METHODOLOGY

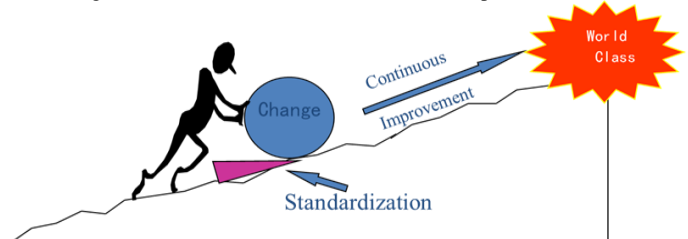
This study is a review of my master thesis "Design of collection and processing system on surface refine mining", which is a research on the introduction, basic meaning and principle of refined mining. Its definition and application in the field was also proposed with the help of a collection and processing system design. This review entails an analysis of extant literature from 1981 to 2015. The refined mining comprehensively adopts advanced technologies in many respects, so as to acquire greatest economic benefits, environmental benefits and social benefits with the addition of refined management integrated with the use of rock mechanics and other multidisciplinary theory. Methods combine with domestic scholars on fine mining and open pit mining theory to analyze the open-pit mine exploitation were used to develop new theory and methods. I also used work done by some scholar's conclusion and methodology in my work. I preliminarily established the basic theory of fine open pit collection system and implemented steps to mining of open-pit mine refinement. Based on fine open pit mining theory, from the first step of refinement based on the information system of mine production, scholars research on the mine information management system, fine characteristics of combined open pit mining, determination of system function by scientific analysis, information collection, content management and designing of the fine open pit mining information collection system with refine management solution where all established. These were done to refine the design and development of open-pit mining information collection, processing and management system.

V. RESULTS AND DISCUSSIONS

Fine mining is today the key of optimization in all mining process. Automotive industry experiences and fine production from extensive production development course can be a great success [13]. Extractive industries should also enter this stage of development (Fine production). The basic principles of Fine production are including the elimination of waste, continuous improvement, teamwork and communication [12]. Optimizations of mining processes are very important to companies wanting to mine as the main aim is to make profit using safe techniques with economically viable resources, shorten time of mining to reduce cost of sustaining the mine site i.e. maintenance of equipment, paying workers at site, and so on [13].

The fine production ideology which is, improvement is never satisfied with the status quo, find the problem, look for the causes, suggest improvements, change working methods and continuously improve the quality of the work [13]. Improvement is incremental progress, which is a slight change and the process is continuous over time. Promoting productivity is also important in optimization and working procedures for it will enhance work speed in a safe manner to prevent accidents, excess incurring of funds and more accurate results. Without standardization, we can't achieve continues improvement in all aspects of fine mining.

Figure 3. Model of standardized baseline for improvement [13]



Stabilizing and improvement are the basic methods of resistance, the key factor in this concept. We can say that fine mining is indeed a continuous way of achieving higher and improved mining procedures. Fine production through the change of the system structure, personnel organization, operation mode, market supply and demand, the production system can adapt quickly to the new mode of production for best results [7,13]. From the general perspective, fine production refers to all resources that occupy less high utilization of all resources. Resources in this context include land, minerals, raw materials, materials, equipment, personnel, time and money.

A. Fine production mainly contains four aspects

First, a proper use of resources, eliminate all possibilities of waste of resources (including materials and labor) and optimization process of arrangements to save manufacturing time. Reasonable arrangements for resource consumption in the manufacturing process mainly refers to the minimum inventory of raw materials, the lowest in the case of normal production inventory; semi-finished minimum idle amount, in the case of normal production, semi-finished fastest transfer speed, the lag time shortest; finished goods with the zero inventory amount that produces fastest. Saving

manufacturing time by optimizing the process of design and rational distribution of the workplace. The fine meaning also including quality, few consume the same amount of materialized labor and living labor conditions because of the high quality products. We can provide better functionality, more reliable performance and longer service life.

Second, to eliminate the waste of resources is a fine production goal. All beyond the necessity to increase the value of product, the absolute minimum of materials, parts of the machine and human resources are all waste. Occupied resources and the use of resources can only make relative comparisons with inventory, and quality can give the absolute standard: zero inventories and zero defect. Zero performance here is a limit that can be infinitely close to it, but can never achieve the "double zero" making improvements continuous.

Third, is to work together. Working together with people of different occupations and expertise can work together in small groups to complete specific tasks. The view of the people for harmonizing the working togetherness is to simplify and centralize the different professions and expertise to improve the quality of work and efficiency improvements, which will be ongoing. Operation workers, maintenance workers, engineers and managers have to work together to make concurrent engineering achievable, which will make the new product of development cycles shorten.

Fourth, is communication. Personnel between departments of the enterprise and customer and supplier need to communicate to transmit information in a timely manner, so that they will have mutual understanding and will work together. Each member of the team must be aware of other member's profession and work content, have a common language and work on a global consideration to avoid one-sidedness [12-17].

IV. CONCLUSION

As an important energy mineral resource, mining faces tremendous shortage on one hand and another aspect also faces enormous waste. The ability to use mineral resources to create wealth gives the country or countries the power to control that mineral market or yet still create a conglomerate of that minerals [2]. More so, is the ability to fully manage those resources and is becoming the focus in the 21st century. There's a great need to take full advantage of the offers that mining system engineering, mining rock mechanics, mining and environmental engineering, and restoration ecology are giving. The study of open-pit mining process is linked with proposed new optimization combined process, quick possible ways to restore the ecological environment to attain significant reduction of production costs and protection of the environment. It offers innovative theories, methods that can protect the environment and at the same time guarantee more production. Fine open-pit mining process can be summarized as follows: within the row of the strip waste rock conditions in the mine, the ore body is divided into small reasonable craft exploitation unit-by-unit, which progressively carries out the stripping, mining, press slope backfill and green or concrete covering. Stripping waste rock near discharge pressure slope as the final slope, which is a permanent, control means to shorten the operating cycle time, reduce production costs and quickly restores the ecological

environment. This study saw the transformation from extensive mining to intensive new form of technicalization and modernization in the mining industry. No field test was carried out as yet, as this was just the first step of which was to establish an ideology, system and develop the concept of fine mining.

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