Analysis and Implementation of the Method for Improving the Grinding Efficiency of Wet Semi-Automatic Mill in Gold Concentrator

Zhongshan Ma[1, 2, 3]

[1]Qinghai Engineering Research Center for Gold Mineral Resource Development Dressing and Metallurgy Pilot Plant, Dulan, Qinghai 816100, China

[2]The Sixth Geological and Mineral Exploration Institute of Qinghai Province, Xining, Qinghai 810000, China

[3]Dulan Jin Hui Mining Limited Corporation, Dulan, Qinghai 816100, China

Keywords: Gold concentrator, wet semi-automatic mill, Grinding efficiency, Lifting method

Abstract: This article focuses on the method of improving the grinding efficiency of the wet semi-automatic mill in the gold concentrator. This paper mainly analyzes the parameters optimization method and simulation modeling process of semi-automatic mill, the optimization of operating parameters of semi-automatic mill, the structure of lining plate of mill and the optimization of material. The purpose is to promote the further development of China's gold beneficiation plant on the basis of ensuring its grinding efficiency.

1. Introduction

The mill is one of the indispensable equipment of the gold beneficiation plant, and the purchase cost of this equipment is relatively high. Once purchased, the mill model cannot be changed. However, in the case of changes in the nature of the ore, the existing equipment and its corresponding process parameters also need to be adjusted and designed in accordance with the specific nature of the ore. Only in this way can the normal production of the gold beneficiation plant be guaranteed. For the nature of the mill, the parameters of the system need to be further optimized to ensure that the parameters are scientifically and reasonably matched under the best working conditions.

2. Semi-Automatic Mill Parameter Optimization Method and Simulation Modeling Process

2.1 The Research Situation of the Operating Parameters of the Semi-Automatic Grinding Machine at Home and Abroad

The optimization of the operating parameters of the semi-automatic mill is a dynamic process, in which the multi-variables and each variable affect each other. One parameter of the semi-automatic grinder has been changed, and other parameters will also have an impact. Therefore, the optimization of the operating parameters of semi-automatic mills at home and abroad has always been the difficulty of scholars. At this stage, the operating conditions of the ball mill are simpler than those of the semi-automatic mill, and the use time is relatively common and the range of popularization is large. Therefore, the research on the operating conditions of this type of mill is relatively mature. At present, the research on the operating parameters of semi-automatic grinding machines at home and abroad mainly adopts the form of software simulation modeling. Among them, the small-scale grinding machine scale-up method requires lower costs, but the experimental data obtained are far from the actual data, and the researchers can only draw regular experiments from the small-scale test mill scale-up method.

2.2 Edem Modeling Process Analysis

2.2.1 Material Definition

The material definition needs to further clarify its physical properties. The materials of the

Copyright © (2020) Francis Academic Press, UK DOI: 10.25236/iwmecs.2020.037

semi-automatic mill are divided into two types, namely steel balls and ores. Enter the hardness, shape and viscosity of the two materials of steel ball and ore into the computer system to automatically obtain the physical properties of the material. In actual research, the shape of the ore has a certain complexity, so the steel ball is the main object of the study of the operation rule of the semi-automatic mill.

2.2.2 Build a Material Factory Model

In the DEEM Particle Factory tool, input the relevant parameters such as the rotation speed, inner diameter, number of liner hardness, installation position and size of the semi-automatic mill, and the material environmental parameters can be automatically generated. This model is called the material factory model. In actual experimental research, the wear of the lining and steel balls is often ignored by DEEM. Therefore, when the mill model is constructed, the test data obtained are not affected by the thickness of the mill barrel and the lining [1].

2.2.3 Selected Data Analysis Methods

The data analysis methods under DEEM are mainly divided into three types according to the different analysis scopes, which are the analysis method within the interface analysis scope, the analysis method within a certain area scope and the analysis method within a certain particle scope. The first analysis method is mainly to study the motion state of the material within the interface; the second analysis method is mainly to study the regional force situation; the third analysis method is mainly to study the particle trajectory.

3. Optimization of Operating Parameters of Semi-Automatic Mill

3.1 The Best Running State of Semi-Automatic Mill

Throwing and venting are the relative movement of internal materials during the normal production of the semi-automatic mill. In the normal operation mode, there is no material in the blank area and inert area of the semi-automatic mill. The position where the material in the throwing area is thrown is on the shoulder, and the material drops along the parabolic flight pattern in the low-angle area of the mill. At this time, the material converts the potential energy in the falling process into kinetic energy, and the speed is continuously accelerated. Once the material falls on the ore, it will form an impact on the ore, which serves the purpose of grinding and crushing. The area is mainly impacted by each other, combined with the impact crushing theory, it is found that the large pieces of ore in the throwing area are easier to crush. Therefore, the main part of the coarse-grained product of the mill is in the drop zone. The ore in the grinding zone is pressed by the above material, and the sliding is the relative movement mode of the ore. In addition, when the ore is in operation with the mill, it will appear to slide down after reaching a certain height. The ore in relative slip is ground. The grinding zone is the main part for producing fine-grained products. The relative movement speed of the materials in the inert zone is very small, so the effects of grinding and crushing are not high. The material in the inert zone will not rotate with the rotation of the mill, so the problem of material waste is serious, but the problem of material waste can be reduced when the filling rate and speed of the mill are selected reasonably.

3.2 Optimizing the Critical Speed of the Mill

The critical speed of the mill refers to the speed when the centripetal force of the material in the mill is equal to its own gravity. At this time, the critical speed of the mill, in which the critical speed of the mill, the effective inner radius of the mill, and the effective inner diameter of the mill are expressed by Cs, R0, and D0, respectively [2].

3.3 Theoretical Optimal Speed of Semi-Automatic Mill

The theoretical optimal speed of the mill is the speed at which the mode grinding efficiency is the highest. Combined with a lot of production experience, it can be known that the detachment angle at the theoretical optimal speed of the mill is 54.75 °. Among them, the detachment angle =

C2 × R0 / 900.

3.4 Turning Speed of Semi-Automatic Mill

The rotation rate of the semi-automatic mill is equal to the ratio between the theoretical optimal speed and the critical speed of the semi-mill. Normally, the rotation speed of the semi-automatic mill is at least 70%, and at most 80%.

3.5 Actual Best Speed of Semi-Automatic Mill

The working conditions of the semi-automatic grinding machine in actual operation are more complicated. For example, the mutual interference between the materials, the rolling of the material, the leakage and the friction will affect the normal operation of the semi-automatic grinding machine. However, the optimal speed only stays at the theoretical level, only considering the role of the mill in the drop zone, but the role of the semi-automatic mill in the actual production of the grinding zone is also very obvious. Fine-grained products are mainly produced in the grinding zone. Therefore, in order to ensure that the materials in the grinding area are fully ground, the operating speed of the semi-automatic grinding machine is generally lower than the theoretical optimal speed, so the actual speed of the semi-automatic grinding machine in operation is C0 = Cs-0.2D. In this formula, the actual speed of the mill is C0, and the diameter of the mill is D. In the actual production of the semi-automatic mill, the parameters such as the height of the liner lifting bar and the angle of the lifting bar will also affect the running track of the materials in the mill. It can be seen that the actual speed needs to be set in conjunction with specific experimental conditions. The actual optimal speed only provides the reference value of the optimal speed [3].

3.6 Optimize the Filling Rate of the Mill

The optimization of the filling rate of the mill requires the selection of the comprehensive filling rate, which is the basis for ensuring the grinding efficiency of the semi-automatic mill. The bulk ore is the grinding medium of the semi-automatic mill. The medium particle size is relatively coarse. Therefore, the amount of steel balls added is less in actual production. The semi-automatic grinder is a lattice type grinder. The comprehensive filling rate of this type of grinder is low, and the low filling rate of the grinder is more common in actual production. According to mass production practice, when 20% is the filling rate of the semi-automatic grinder, the material at this time is in a throwing state, the material in the bottom corner area is insufficient, and the problem of the steel ball hitting the lining board frequently occurs. When 30% is the filling rate of the semi-automatic mill, the material is in the best operating state at this time, and then when the filling rate is gradually increased to 40% or 50%, the material in the drop zone of the mill will rise in a short time, resulting in the mill The operation is limited to a small area on the surface of the material. In the case where the relative operation volume is reduced, the grinding efficiency cannot be improved. The operation power of the semi-automatic mill was studied, and it was found that the operation of the mill at low speed and low filling rate requires less cost and more economical. Therefore, when the rotation speed of the semi-automatic mill is 12.5r / min and the filling rate is 30%, the grinding efficiency of the semi-automatic mill is the highest [4].

4. Mill Liner Structure and Material Optimization

The impact force of the lining plate of the semi-automatic grinder is greater than the grinding force. Therefore, it is a prerequisite for the design of the lining plate to ensure a certain hardness of the lining plate. On this basis, the toughness of the lining plate is improved. High-manganese alloy steel is the best material used in the design of the lining board. This material has good impact toughness. The lining board of this material is to add trace elements such as Cr, MO, V, Ni and the like to the original lining board. These elements combine with carbon in steel to form carbides with high melting points. The lining plate of this material can reduce the penetration rate of carbides between the steel structures, achieve the purpose of refining the lining plate, and promoting the improvement of the internal crystal structure. In the process optimization, heat treatment technology is adopted, which solves the shortcomings of the traditional “following furnace cooling + annealing treatment” process. In the case of a short holding time, a high hardness liner can be obtained. In addition, the addition of chromium to the liner can further increase the hardness of the liner. According to relevant data research, the improved liner is tested by Vickers hardness machine, and the surface hardness and internal hardness of the liner have reached 300HV and 185HV respectively [5-6].

5. Conclusion

In summary, the above is an effective method to improve the grinding efficiency of the wet semi-automatic grinding machine of the gold concentrator analyzed in this article. I hope that the summary in this article can play a certain role in the research in this field and further improve the gold concentrator in China Productivity.

Acknowledgement

The authors acknowledge the support of the Qinghai Science and Technology Program of China (No. 2019-SF-139).

References

[1] Diao Xiaogang, Li Wei, Wang Chunmin, et al. Optimization and application of large semi-self-milling machine cylinder liner structure. Mining Machinery, Vol.48, No.2, pp.39-44, 2020.

[2] Xie Zhuohong, Zhang Suigeng. Improvement of the structure of semi-automatic mill and ball mill liner. Nonferrous Metals (Mineral Processing Section), No.1, pp.73-77, 2019.

[3] Pan Qing, Zhang Bijun. Design and application of semi-automatic grinder arc lattice plate-lifter [J]. Mining Machinery, Vol.47, No.4, pp.28-31, 2019.

[4] Zang Baojin, Zhang Zhentao, Liu Zibing. Damage analysis and modification practice of grid plate of semi-automatic mill. Global Market, No.22, pp.354+357, 2019.

[5] He Zhiwen. Analysis and implementation of the grinding efficiency improvement method of the wet semi-automatic mill in the gold concentrator. Shandong: Shandong University, 2018.

[6] Mei Xiong, Wang Chuanfeng. Practice of improving semi-self-grinding efficiency of carnallite mine. Chemical Minerals and Processing, Vol.45, No.10, pp.65-67, 2016.