Research on Optimization of Metallurgical Process Based on Data-Driven

Meng Wang

Business School, Anhui University of Technology, Maanshan 243002, China.

360408695@qq.com

Abstract

The issue of resources has become a fundamental issue in our country's sustainable development strategy. Hydrometallurgy has the advantages of being able to handle complex ore, low-grade ore, and less environmental pollution, so many new hydrometallurgy processes are emerging and widely used. China's hydrometallurgy optimization control technology is developing slowly, and it is difficult for mineral resources to be used with high efficiency and low consumption. This paper optimizes the operation mode theory and intelligent control process of the complex non-ferrous metal production process through data-driven methods.

Keywords

Hydrometallurgy; data-driven; process optimization.

1. Introduction

Mineral resources are not only the basis for economic and social development, but also a key factor that restricts economic and social development. The issue of resources has become a fundamental issue in the sustainable development strategy of China and even the world. On the one hand, with the rapid development of the national economy and the continuous advancement of industrialization, China's demand for mineral resources is increasing. China has accelerated the development and utilization of mineral resources. Minerals with high grades and high development value are rapidly declining. The supply of mineral resources is facing unprecedented pressure. On the other hand, China is rich in low-grade nonferrous metal resources. The recovery of mineral resources from poor, fine, and miscellaneous minerals has important practical significance for the sustainable economic and social development of China. Hydrometallurgical processes include typical processes such as leaching, thick washing, extraction/replacement, and the like. The optimization and control of each typical process is the basis for achieving the optimal operation of the entire hydrometallurgical process. The leaching process is the first process of hydrometallurgy. The quality of the leaching solution directly determines the purity of the extracted metal, the metal recovery rate, and the consumption of raw materials in the subsequent process. Therefore, the optimization control of the leaching process makes the leaching process always the best. The operating status is particularly important..

1.1 Research Status of Optimizing Settings for Hydrometallurgy

1.1.1 Current Research Status of Hydrometallurgy

In industrial process control, we usually consider designing the controller and automatic control system to ensure the stability of the closed-loop system, so that the controlled object or the controlled variable can track the set value of the control system as accurately as possible. However, in the actual production process, we not only want to see that the system is stable, the controlled quantity can track the set value, and we also hope to see that it can reflect the quality, efficiency, material consumption

and energy of the product in the processing process. Consumption and other indicators are within the target range. However, previous studies have generally focused on improving the effectiveness of feedback control, and they have not been concerned with whether the set point can be obtained. When deviating from the ideal set point, the feedback control system does not work well. In recent years, the optimal control of the operation of complex industrial processes has attracted many scholars to conduct research. However, due to the close correlation between industrial processes and industry knowledge, there has been no optimal control method that has achieved good results for various industrial processes. Hydrometallurgy itself as a complex industrial process, its optimal control also received the attention and research of many scholars. However, there is currently no general optimization control method that can realize the operation of the metallurgical industry. Only the control method for the specific metallurgical process operation, such as [1].

combines the conventional control and intelligent control technology for the laminar cooling process of hot rolling, and proposes Mixed monitoring methods to improve the performance of the final product. Reference [2] proposed a mixture of control circuit setting layers consisting of rinsing water flow rate, excitation current and ore concentration loop control layer and control loop setting model based on data inference, and feedback compensator based on rule inference.[3] Intelligent control methods, concentrate grade and tailings grade are controlled within the target value range. Chai Tianyou and Yang Xun of the Northeastern University Automation Research Center have proposed the realization of rare earth products for the problems of high production costs, poor consistency of product quality, and high resource consumption caused by the generally low level of automation equipment for rare earth industrial production processes in China. The synthetic automation system for the rare earth extraction and separation production process that optimizes the integrated production indicators such as purity, metal recovery rate, and product output, discusses the system structure, function, and extraction of an integrated automation system consisting of a two-layer structure of a production process management system and a process control system. The optimization control strategy of the export product component indicators at the two ends of the separation process is the target. The proposed system was applied to the HAB extraction and extraction of a company's production process and achieved good application results. The Beijing Research Institute of Mining and Metallurgy conducted research on instrumentation automation and industrial control computer applications in pulp ore electrolysis, bioleaching, extraction, pressure leaching, and other laboratories or pilot test bases, and achieved good research results.

1.1.2 Current Research Status of Data Driven Optimization Settings

Data-driven control was first introduced into the field of computer science due to its enormous advantages The application prospects are also highly valued by the theoretical circles in the field of control. Data-driven control says "The beginning of control Both points and targets are data, which is a "closed-loop approach." It is parallel to model-based optimization control. System performance analysis and controller design method. The definition of data-driven control is: "The controller design does not contain the information of the mathematical model of the controlled process but uses only controlled The system's online and offline I/O data and knowledge gained through data processing are used to design controllers Under the assumptions, there are control theories and methods of convergence, stability, and robustness. Or simply, It is the control theory and method directly from the data to the controller design [4] From the definition of data-driven control we can see that it only needs the system's I/O data to complete the control. The design of the device bypasses the challenge of establishing a complex industrial engineering mechanism model and is welcomed by control engineers. welcome. After decades of development, data-driven control theories or methods have been gradually enriched and improved. Currently The system is relatively complete, the theory is relatively independent: PID control, model-free adaptive control method (Model Free Adaptive Control (MFAC), Iterative Learning Control (I £ C), Iterative Feedback Iterative Feedback Tuning (IFT), Unfalsified Control (UC), based on neural Various Intelligent Control Theory of Network and Control Method of Support Vector Machine [l0] Data-driven optimization methods, compared to the

traditional optimization method based on the mechanism model, in the face of large The amount of off-line, online data has tremendous advantages.

Especially in today's complex industrial processes, companies The scale of production is increasing, and the production process, production equipment and production processes are becoming more and more complex. The traditional method, The physicochemical mechanism establishes precise mathematical models, and controls, forecasts and evaluates production processes and equipment It becomes more and more difficult. At this time, the data-based method can start from the large amount of data accumulated every day, avoiding the establishment of Mechanism model to explore the process changes and equipment operations contained in a large number of production, equipment and process data To achieve optimal control, forecasting and evaluation of production processes and equipment

2. The Implementation of The Optimization and Setting System for Hydrometallurgy

2.1 System Hardware Structure

The main content of the structural design of the part is the analysis and analysis of the system, the design of all the hardware devices and the wiring and communication between the devices. Data-driven optimization of the entire process of hydrometallurgy to set the system hardware is mainly composed of the lower machine PLC, database, client interface, the use of Ethernet communication between the three. [5] The function of each device is as follows:

1) PLC monitoring computer

The PLC is mainly responsible for collecting production data at the site, and the PLC monitoring computer is mainly responsible for the communication between the OPC service and the PLC built by Step7 in Siemens WinCC, and saves the on-site production data to the server.

2) Server

Server refers to a computer device that manages resources and provides services to users. It is usually divided into file server, database server, and application server. Compared to ordinary computers, servers have higher requirements in terms of stability, security, and performance. Therefore, the system selects the database server to be responsible for the exchange and storage of on-site data, provides data processing for the system to provide data sources, and ensures the normal and stable operation of the data exchange of the system.

3) Full-flow client

The full-flow client mainly provides clients for optimizing the entire process of hydrometallurgy, and the main functions include various functional modules such as data monitoring and processing, and the optimized setting operation is based on the collected data.

2.2 Optimization Design System Function Design and Implementation

The overall structure of the data-driven hydrometallurgy full-flow optimization setting system is shown in Figure 1. Its main function is operating status. Monitoring, case generation, case retrieval, case correction [6].

The optimization setting system reads the current operating condition information in the server and displays it in the corresponding process of the hydrometallurgy full-flow simulation diagram, so that the on-site production personnel can clearly monitor the current operating status;

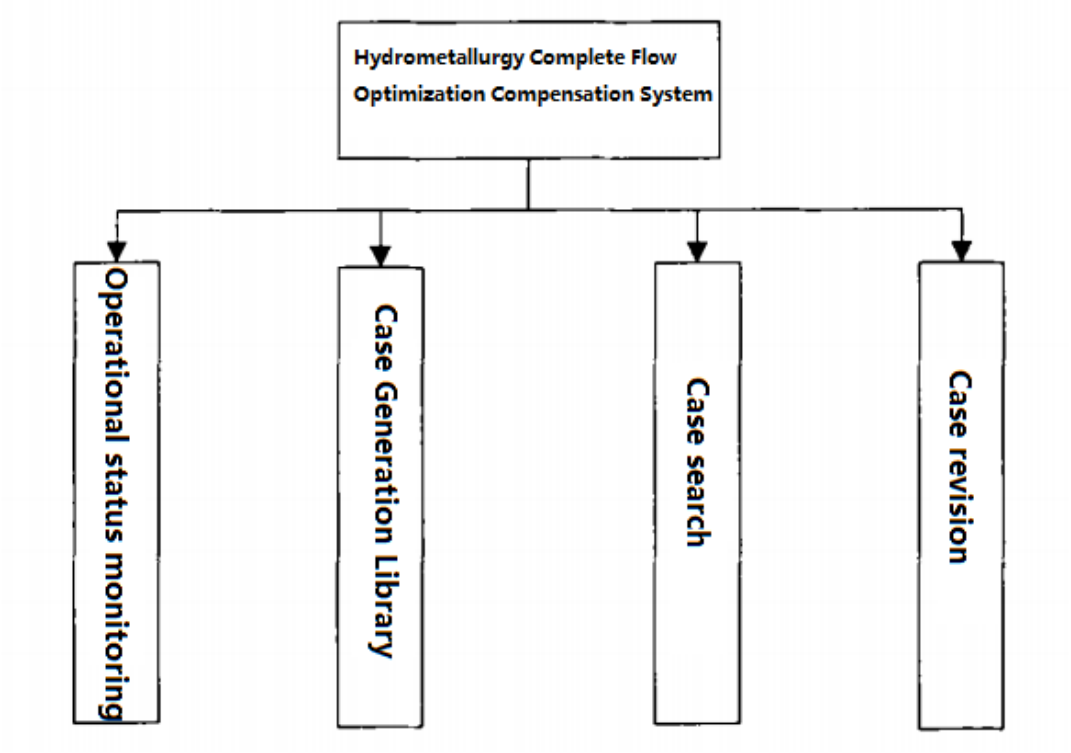

Fig 1. Structure function ofthe system

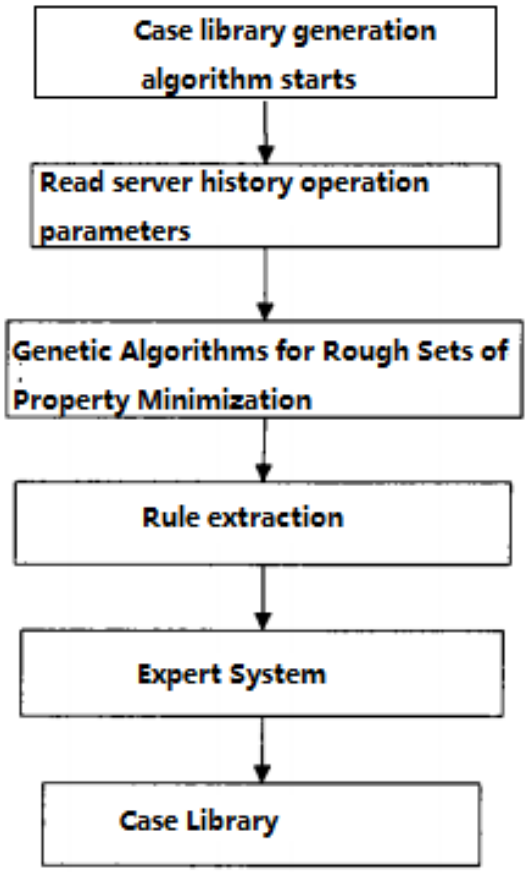

Fig 2. Case library generation flow chart

The optimization setting system reads the current working condition information in the server and displays it in the corresponding process of the hydrometallurgy full-flow simulation diagram, so that the on-site production personnel can clearly monitor the current operation status: the process of the

case library generating function As shown in Figure 2, the history condition parameters stored in the server are read first, and then the rough set attribute reduction extraction rules based on the genetic algorithm proposed in the previous section are extracted. Finally, the expert experience is used to select rules to form a case base. The case retrieval function is to search out cases that have a degree of similarity with the target case that is greater than the threshold value from the case base, that is, cases that are similar to the current working condition, and select the optimal comprehensive economic indicator case for reuse under similar conditions. The case correction function can save the case of new cases and revises the case after reusing the case, so that the case library contains more working condition information and solutions, and the system's ability to solve problems is continuously enhanced.

3. Conclusion

The level of hydrometallurgy in China is very mature, but its corresponding degree of automation is very low. Especially in the situation where China has a lot of low-grade non-ferrous metal resources, it is urgent to increase the level of automation of hydrometallurgy. Hydrometallurgy optimization setting technology as an important part of the level of automation, it is necessary and meaningful to carry out in-depth research. Because hydrometallurgy is a complex industrial process with characteristics such as non-linear, multi-variable, and strong coupling, it is very difficult to establish an accurate process model for it. The data-based approach has unique advantages. It can bypass the mechanism model, extract information from only a large amount of operational data accumulated in the field, and then use data mining methods to sum up the relationship between various variables, so as to guide on-site production. The steady progress.

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References

[1] Jing Jinxiang, Chai Tianyou. Hybrid intelligent control method for laminar cooling process of hot rolled strip [J], Journal of Northeastern University (Natural Science), 2009, 30(11): 1534.1537.
[2] Chai Tianyou, Ding Jinliang, Wang Hong et al. Hybrid intelligent optimization control method for complex industrial process operation [J], Journal of Automation, 2008,34(5):505-5 1 5.
[3] Chai Tianyou, Yang Hui. Research status and development trend of automatic control of rare earth extraction separation process [J], Journal of rare earths, 2004,22(4):427-43 3.
[4] Hou Zhongsheng, Xu Jianxin. Review and Prospect of Data Driven Control Theory and Method [J], Journal of Automation, 2009, 35(6):650-667.
[5] Z Wang.D Liu.Data·based controllability and observability analysis of linear discrete— time systems[J1.IEEE Transactions on Neural Networks,201 1,22(12):2388-2392.
[6] Z S Hou.S T Jin.Data-driven model-free adaptive control for a class of MIMO nonlinear discrete-time systems[C],IEEE Transactions on Neural Networks,201l,22(12):2173- 2188.