Accepted Manuscript

Prediction Model of Slurry pH based on Mechanism and Error Compensation for Mineral Flotation Process

Xiaoli Wang, Lei Huang, Chunhua Yang

PII: S1004-9541(17)31470-2
DOI: doi:10.1016/j.cjche.2018.06.012
Reference: CJCHE 1177

To appear in: *Chinese Journal of Chemical Engineering*

Received date: 30 October 2017
Revised date: 2 February 2018
Accepted date: 11 June 2018

Please cite this article as: Xiaoli Wang, Lei Huang, Chunhua Yang , Prediction Model of Slurry pH based on Mechanism and Error Compensation for Mineral Flotation Process. Cjche (2018), doi:10.1016/j.cjche.2018.06.012

Article

Prediction Model of Slurry pH based on Mechanism and Error Compensation for Mineral Flotation Process☆

Xiaoli Wang*, Lei Huang, Chunhua Yang

School of Information Science and Engineering, Central South University, Changsha 410083
*Corresponding author.E-mail: xlwang@csu.edu.cn

Abstract: A suitable pH value of the slurry is a key to efficient mineral flotation. Considering the control delay problem of pH value caused by offline pH measurement, an integrated prediction model for pH value in bauxite froth flotation is proposed, which considers the effect of ore compositions on pH value. Firstly, a regression model is obtained for alkali (Na_2CO_3) consumed by the reaction between ore and alkali. According to the first-order hydrolysis of the remaining alkali, a mechanism-based prediction model is presented for the pH value. Then, considering the complexity of the flotation mechanism, an error prediction model which uses time series of the error of the mechanism model as inputs is presented based on auto regressive moving average (ARMA) method to compensate the mechanism model. Finally, expert rules are established to correct the error compensation direction, which could reflect the dynamic changes during the process accurately and effectively. Simulation results using industrial data show that the presented model meets the needs of the industrial process, which laid the foundation for predictive control of pH regulator.

Key Words: Froth flotation, PH value prediction, hydrolysis, Mechanism model, ARMA, Expert rule

INTRODUCTION

In mineral processing, the pH value of slurry has a direct impact on the compositions of the ions in the slurry, the activity of the flotation reagents and the floatability of the minerals [1]. Only with appropriate pH value, the process could get optimal flotation performance. However, usually, from the location where pH regulator is added to where it is detected, there exists a time delay that would cause the control delay of the pH value. Moreover, due to the poor environment and the quick deposit of the solid particles, online measurement of pH value is easy to become inaccurate and the equipment is easily jammed and damaged [2]. Then, the dynamic process cannot be monitored in real-time, which exacerbates fluctuations in pH value. In the actual production process, operators detect pH value offline and adjust reagent addition manually to control slurry pH, which leads to heavy workload, bad real-time performance and unstable working conditions. Therefore, predicting the pH value of slurry accurately and real-time has great significance for optimization of flotation process.

In saline mineral flotation process, the slurry pH is not only concerned with the pH regulator and water addition, but also related to ore compositions. Dissolved ore components may have a great influence on flotation [3]. The relationship between the ore and the pH regulator is complex. In order to find optimal pH range in flotation process, the recovery rate and concentrate grade of useful minerals under different pH values has been studied [4-6]. However, for the bauxite, the research on the effect of ore to pH regulator is very rare, and then the pH regulator addition almost entirely depends on operators' experience.

Soft-sensing and prediction modeling are effective ways to solve the problem that the process variables are difficult to detect on-line. Considering the static models would become more and more inaccurate as time passes, adaptive methods [6][11], or model (parameters) updating strategy [12][13] and dynamic modeling methods [14][17] are usually used to improve model adaptability. The above methods could improve the model performance to some extent, but it has its applicable conditions [18]. Moreover, there is still much work to do on nonlinear and dynamic modeling. As to the slurry pH, in ref. [19], a soft-sensing model is proposed, which use the froth surface features as auxiliary variables, however, this model cannot predict pH value accurately when the process variables, such as dosage, ore input or the water flow rate, and so on, change suddenly. Meanwhile, these models are essentially for soft-sensing, but not suitable for prediction. Flotation is a long process, and there are many external factors interfere with the interactions of pH regulator and ore, which makes the pH value change in a strong-nonlinear and dynamic behavior. Therefore, further studies on prediction and control are required.

In this paper, to solve the detection delay problem of slurry pH in bauxite froth flotation, an integrated prediction model for slurry pH is established. Firstly a regression model is obtained for alkali (Na_2CO_3) consumed by the reaction between ore and alkali. Secondly, considering the first-order hydrolysis of the remaining alkali, a mechanism-based prediction model for pH value is presented. And then, according to the time series of the pH error which is the difference between the measured value and the predicted value of the mechanistic model, an error compensation model is established based on autoregressive moving average (ARMA). Finally, expert rules are presented to correct the error compensation

☆ Supported by the National Nature Science Foundation of China(61673401), the Foundation for Innovative Research Groups of the National Nature Science Foundation of China(61621062), the Fundamental Research Funds for the Central Universities of Central South University(2016zzts343)