A GA-based numerical technique for HPGR model fitting and simulation

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ABSTRACT

Modeling and simulation of comminution circuits are widely used by engineers to design and optimize mineral processing operations. In this study, implementation of a HPGR model in MATLAB environment was investigated. This program was also validated by using laboratory and pilot scale HPGR data sets. The Genetic Algorithm (GA) search toolbox of MATLAB was used for validation and calculation of model parameters. These calculated parameters were considered constant for feed and the HPGR unit under study. Then, operating conditions including roll pressure and speed, roll's gap and flake density were changed. Afterward, above-mentioned parameters were used for predicting the product size distribution. The final results demonstrate that GA can be used successfully to search and find the best values of HPGR model parameters. Also, the close agreement between measured and predicted product size distributions confirms the accuracy of the implemented model and the correctness of the programmed computational procedures in MATLAB environment.

Keywords: comminution; high pressure grinding roll; simulation; Genetic Algorithm

INTRODUCTION

Comminution circuits have the highest level of energy consumption in mineral processing plants. So, improving comminution devices to increase the performance and to decrease energy consumption are always an important part of engineers and manufacturers' researches. HPGR is the result of basic changes in roller crushers and for the first time were done by Schönert. Subsequently, the comminution mechanism was changed in the new crusher due to its high pressures (Schönert, 1986; Schönert, 1979). High throughput capacities of HPGR and its low specific energy consumption made it more attractive for use in comminution circuits.

Modeling and simulation packages are widely used by mineral processing engineers for prediction or optimization of pre-existing comminution circuits. With respect to modeling of high pressure grinding roll, the most considerable works were done by Morrell and some co-assistants (Morrell et al, 1997; Daniel and Morrell, 2004). Recently, a new method was developed for modeling of HPGR by Torres and Casali (Torres and Casali, 2009). Authors of this new method believe that the presented model by Morrell and Daniel has several uncertain points (Torres and Casali, 2009). In the model that is presented by Daniel and Morrell, outputs of drop weight apparatus are used for ore characterization, but in this new method, functional expression of breakage and selection functions are used for this purpose. Related parameters of this functional expression should be calculated by fitting of model with experimental data. There are six parameters that should be calculated that three of them are breakage functions and other parameters are selection functions.

Implementation of model equations in suitable programming environment with powerful optimization tools is needed for fitting the model with experimental data and calculation of model parameters. Genetic Algorithm search pattern as an optimization tool has been used by many researchers to optimize comminution circuits (Farzanegan and Vahidipour, 2009). So in this study, MATLAB environment that includes Genetic Algorithms as optimization tool was selected for implementation of model, obtaining of model parameters and finally prediction of HPGR product size distribution in open circuit.

DESCRIPTION OF HPGR MODEL

The HPGR model that is used in this study is the model that was presented by Torres and Casali (Torres and Casali, 2009). This model includes a set of equations that is based on ore characteristics, equipment dimensions and operating