Numerical study of continuous grinding processes

M. H. Kouhkamari*, R. Yang+ , K. Dongγ and A. B. Yu†

* Laboratory for simulation and modelling of particulate systems (SIMPAS), School of materials science and engineering, UNSW Australia, Sydney , Australia
e-mail: m.hosseinikouhkamari@student.unsw.edu.au, web page: http://www.simpas.unsw.edu.au/

+ Laboratory for simulation and modelling of particulate systems (SIMPAS), School of materials science and engineering, UNSW Australia, Sydney , Australia
e-mail: r.yang@unsw.edu.au, web page: http://www.simpas.unsw.edu.au/

γ Institute for Infrastructure Engineering, University of Western Sydney, Sydney, Australia
e-mail : k.dong@uws.edu.au, web page :
http://www.uws.edu.au/iie/people/research_academics/doctor_kejun_dong

† Department of chemical engineering, Monash University, Melbourne, Australia
e-mail: Aibing.Yu@monash.edu, web page: http://www.simpas.unsw.edu.au/

ABSTRACT

Grinding is an important size reduction process in many industries. According to the literature, there are still some unanswered questions and gaps in investigating the DEM model for grinding. The main shortcoming of existing models is that they are not able to simulate the continuous size reduction of particles in grinding systems. It is also clear that there are still many negative aspects associated with the present methods which have been developed so far and there is a need for a method which is aimed to be properly designated to scale-up a grinding process to operate at its optimum operating conditions. Thus, a small progress in the efficiency of grinding progress will cause an enormous economic profit to industries. While the batch grinding has been studied extensively, there is little effort to develop a predictive model of the continuous grinding processes.

In this study, a continuous-grinding ball mill is investigated using the discrete element method (DEM) based model. Collision energy, collision frequency and residence time of particles obtained from the DEM simulation are linked with experimental data using population balance model (PBM) to predict the product size distribution. The model is verified by comparing with the results from experiments. To properly scale-up and optimize the operating condition, the effects of operation conditions such as drum inclination, number of lifters, rotating speed, ball loading and ball size are also studied.

REFERENCES

[1] MORRELL, S. & MAN, Y. 1997. Using modelling and simulation for the design of full scale ball mill circuits. Minerals engineering, 10, 1311-1327.
[2] ROZENBLAT, Y., GRANT, E., LEVY, A., KALMAN, H. & TOMAS, J. 2012. Selection and breakage functions of particles under impact loads. Chemical Engineering Science, 71, 56-66
[3] RAJAMANI, R. K. & HERBST, J. A. 1991. Optimal control of a ball mill grinding circuit—I. Grinding circuit modeling and dynamic simulation. Chemical Engineering Science, 46, 861-870.
[4] WANG, M., YANG, R. & YU, A. 2012. DEM investigation of energy distribution and particle breakage in tumbling ball mills. Powder Technology, 223, 83-91.
[5] A. Datta, R.K. Rajamani, A direct approach of modeling batch grinding in ball mills using population balance principles and impact energy distribution, International Journal of Mineral Processing 64 (2002) 181–200.