Discrete Element Method Modeling of Ball Mills Liner Wear Evolution

D. Boemer*, S. Rycerski†, J. Vis† and J.-P. Ponthot*

* Aerospace and Mechanical Engineering Department/LTAS-MN2L
University of Liège (ULg)
Allée de la découverte 13A, 4000 Liège, Belgium
e-mail: dominik.boemer@gmail.com, e-mail: jp.ponthot@ulg.ac.be
web page: http://metafor.ltas.ulg.ac.be

† Magotteaux International S.A.
Rue A. Dumont, 4051 Vaux-sous-Chèvremont, Belgium
web page: http://www.magotteaux.com/

ABSTRACT

Ball mills, i.e. rotating cylindrical drums filled with a feed material and metal balls, also known as the charge, are a major category of grinding devices in mineral processing and cement production. Since the grinding process is excessively energy-intensive and aggressive in terms of wear, a profiled and wear-resistant liner is installed in the mill to transfer energy to the grinding charge more efficiently and to protect the mill shell. Because of the harsh environment inside of the mill and the relatively long lifespan of its liner, the optimization of this liner by the classical way, i.e. experimental testing, is a difficult and slow process.

A numerical procedure for predicting the charge motion and the power draw of a ball mill based on the discrete element method (DEM) was therefore calibrated and validated by means of photographs of the charge, and power draw measurements of a 1:5-scale laboratory mill. This computational method essentially renders future experimental testing unnecessary with respect to these characteristics.

On the basis of this first method, a generic process for predicting the wear distribution and the progressive shape evolution of liner surfaces is developed and validated by the wear profiles of the shell liner in the first chamber of a 5.8 m diameter cement mill monitored during a decade by Magotteaux International S.A. The energy dissipated by tangential damping defined by the linear spring-slider-damper DEM contact law was found to be the best fitting wear model with respect to the real wear data. The progressive update of the liner geometry by a multi-step procedure delivers relatively accurate results for liners without axial height variation while further investigations are still required for almost fully variable geometries. Nevertheless, detailed phenomena, like the creation of grooves in the liner, were for the first time numerically modeled.

Keywords: ball mill, discrete element method, liner wear

REFERENCES

[1] D. Boemer, *Discrete Element Method Modeling of Ball Mills – Liner Wear Evolution*, Master's Thesis, University of Liège (2015).