Modeling and simulation of a granulation system using a nonsmooth discrete element method

M. Servin*, T. Berglund#, K-O. Mickelsson† S. Rönnbäck¤ and D. Wang*

* Department of Physics / UMIT Research Lab
Umeå University, SE-90187 Umeå, Sweden
e-mail: martin.servin@physics.umu.se, da.wang@physics.umu.se,
web page: http://www.org.umu.se/umit

Algoryx Simulation, Umeå, Sweden.
e-mail: tomas.berglund@algoryx.se, web page: http://www.algoryx.se

† LKAB R&D, Malmberget, Sweden.
e-mail: kjell-ove.mickelsson@lkab.com, web page: http://www.lkab.com

¤ Optimation, Luleå, Sweden.
e-mail: stefan.ronnback@optimation.se, web page: http://www.optimation.se

ABSTRACT

Granulation is the process of forming macroscopic granules, e.g. tablets or pellets, from microscopic particles. A common system for continuous granulation consist of a rotary drum or disc, a sieve and chrusher connected in a circuit by a number of conveyors. The granulation occur in the drum (or disc) and the main mechanisms are nucleation, layering, coalescence and breakage [1]. The process can be controlled by drum velocity and feed rate of fine material, binding agencies and moisture. The geometric design of components affect the material flow and thus the sieving capacity and ultimately the production capacity. Many granulation plants operate well below their capacity and suffer from high recycle rates and dynamic instabilities [2].

The main challenge of modelling and simulation of granulation processes is the occurrence of multiple length and time scales. The traditional approaches are typically focused either the large-scale level of processing units or on the microscale level of particles. A complete model of a granulation process need to include also the intermediate scale of granule dynamics [1]. This is, however, a very challenging computational task given the vast number of granules, typically many millions or more.

We present a meso-scale approach to modeling and simulating iron ore granulation systems with granules modeled as nonsmooth discrete elements (NDEM) [3-6]. This extend a previous iron ore granule model [7] used for balling drum outlet design simulation [8]. Ore fines and moisture is modeled by a quasiparticle model for slurry [9]. Interaction models for nucleation, layering, coalescence and breakage are proposed and tested in a virtual balling circuit. The computational performance is analysed and different methods for accelerating the NDEM computations are tested.

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