



HAL
open science

3D simulations of the granulation of wet granular materials

Thanh-Trung Vo, Patrick Mutabaruka, Saeid Nezamabadi, Jean-Yves Delenne, Farhang Radjai

► **To cite this version:**

Thanh-Trung Vo, Patrick Mutabaruka, Saeid Nezamabadi, Jean-Yves Delenne, Farhang Radjai. 3D simulations of the granulation of wet granular materials. Second Yet Another Discrete Element Workshop, Apr 2018, Aix-en-Provence, France. hal-01778011

HAL Id: hal-01778011

<https://hal.science/hal-01778011v1>

Submitted on 25 Apr 2018

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

3D simulations of the granulation of wet granular materials

Thanh-Trung Vo^{1,2}, Patrick Mutabaruka³, Saeid Nezamabadi¹, Jean-Yves Delenne⁴, Farhang Rad-jai^{1,3}

¹ Laboratoire de Mécanique et Génie Civil, Université de Montpellier, CNRS, Montpellier, France.

² Bridge and Road Department, Danang Architecture University, Danang, Vietnam.

³ <MSE>, UMI 3466 CNRS-MIT, MIT, 77 Massachusetts Av, Cambridge 02139, USA.

⁴ IATE, UMR1208 INRA-CIRAD-Université de Montpellier-SupAgro, Montpellier, France.

thanh-trung.vo@umontpellier.fr

Keywords: size ratio; capillary bridge; molecular dynamics; rotating drum; iron ore

Agglomeration of fine particles is used in many industrial processes such as powder metallurgy (Nosrati et al. 2012), iron-making industry (Aguado et al. 2013), food and pharmaceutical industries (Chien et al. 2003). Fine granular materials are prepared and mixed in required proportions, compacted into a granule or tablet and finally sintered to acquire sufficient mechanical strength and toughness needed for subsequent operations. We present a numerical model for the agglomeration of wet particles. The particles interact through capillary liquid bridges, which are modeled by accounting for the cohesive and viscous forces expressed analytically as a function of different parameters such as the distance between primary particles, liquid volume and viscosity, surface tension and particle sizes (Richefeu et al. 2007). The model also assumes that the liquid is transported by the primary particles modeled as agglomerates of finer particles. We find that this model is able to simulate the agglomeration of particles in a rotating drum in which a given amount of liquid is homogeneously distributed. Our simulation show that the granule size increases exponentially with the number of drum rotations and in proportion to the amount of liquid. We investigate the effects of process parameters such as particle size distribution, friction coefficient between the primary particles and liquid viscosity. We also consider the effect of cohesion on different flow regimes as a function of Froude number.

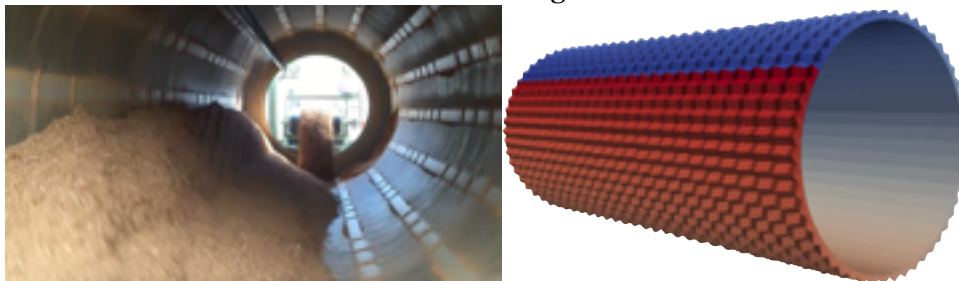


Figure 1 Industrial and numerical granulation drum.

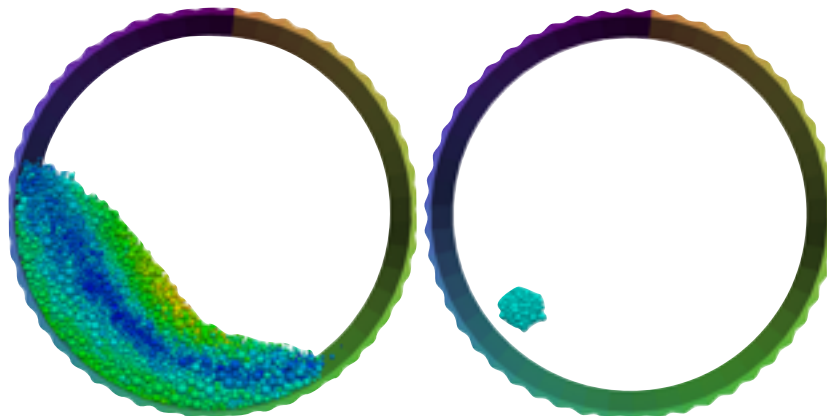


Figure 2 Snapshots represent the agglomeration process of solid particles in a horizontal rotating drum, granular flow on the left and granule is formed and it grows with the number of rotations of drum on the right.

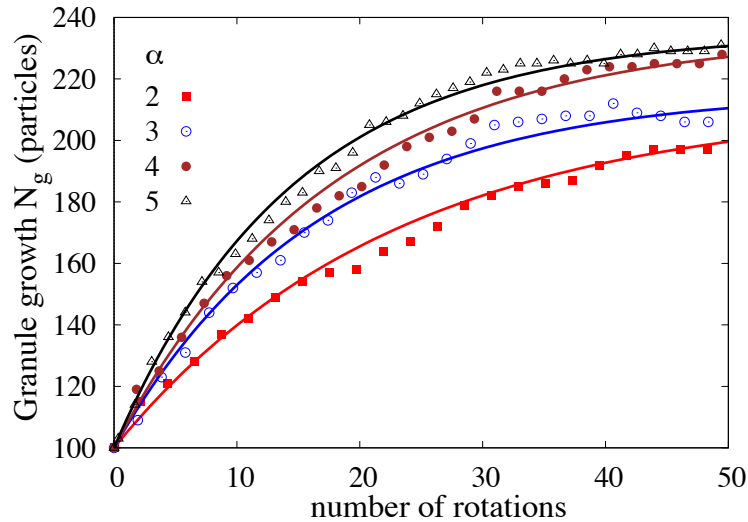


Figure 3 The evolution of the size of the granule as a function of the number of rotations for different values of the size ratio.

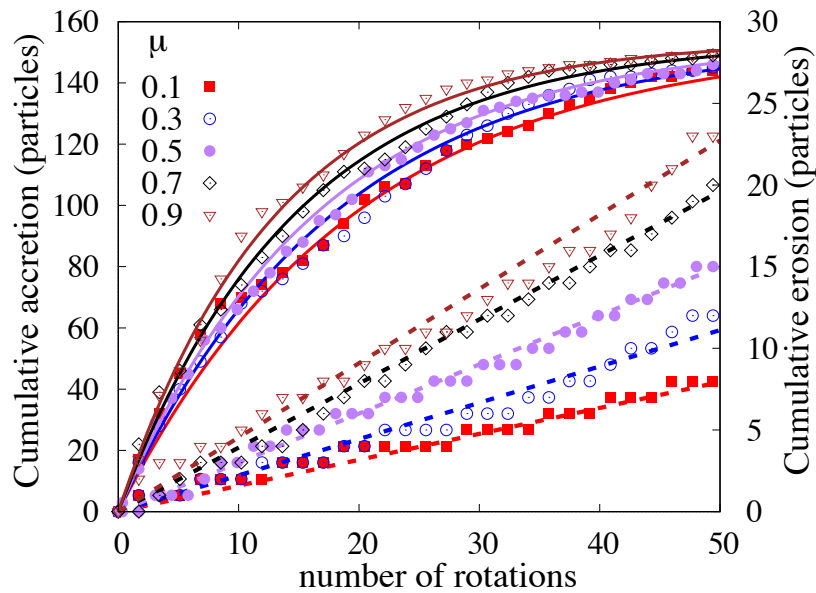


Figure 4 The exponential increase function of accretion (continuous lines) and the nearly linear function of erosion (dash lines) for different values of friction coefficient.

References

A. Nosrati, J. Addai-Mensah, D.J. Robinson. (2012), *Drum agglomeration behavior of nickel laterite ore: Effect of process variables*, Hydrometallurgy 125–126, 90

R. Aguado, S. Roudier, L. Delgado. (2013) *Best available techniques (BAT) reference document for iron and steel production*, Joint Research Centre of the European Commission.

S.H. Chien, G. Carmona, L.I. Prochnow, E.R. Austin. (2003), *Cadmium availability from granulated and bulk-blended phosphate-potassium fertilizers*, J Environ Qual 32 (5), 1911

V. Richefeu, F. Radjai and M.S.E. Yousoufi. (2007), *Stress transmission in wet granular materials*, Eur. Phys. J. E 21, 359