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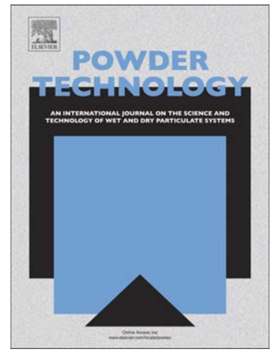

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DEM simulation on the vibrated packing densification of mono-sized equilateral cylindrical particles

Quan Qian[a], Lin Wang[a], Xizhong An[a*], Yongli Wu[b], Ju Wang[a], Haiyang Zhao[a], Xiaohong Yang[a]
[a] School of Metallurgy, Northeastern University, Shenyang 110004, PR China
[b] Department of Chemical Engineering, Monash University, Clayton, Victoria 3800, Australia

Abstract

The packing densification of mono-sized equilateral cylindrical particles under mechanical vibration is numerically reproduced using discrete element method (DEM). The influences of vibration frequency, amplitude and container size on the macro property (e.g. packing density) of each packing are studied. Meanwhile, various micro-properties including coordination number (CN), radial distribution function (RDF), local structures, contact types, particle position/orientation distributions, forces/stresses of the vibrated dense packing are characterized and compared with those of the loose initial poured packing. The results show that properly controlling vibration conditions can realize the transition of equilateral cylindrical particles from random loose packing (RLP) to random close packing (RCP). The maximum packing density without wall effects can reach about 0.7166, which agrees with experimental and numerical results in literature. Micro property analyses demonstrate that the average CN increases slightly after vibration. The RDF curves indicate three obvious peaks for both poured and vibrated packings. The distributions of intersection angles imply that the perpendicular arrangements of the cylindrical particles are common in both packing structures. From RLP to RCP, the probability of side-edge, bottom-edge and edge-edge contacts between two particles decreases, while that of side-side, side-bottom and bottom-bottom contacts increases. Both particle position and orientation distributions illustrate that the structure in the center of the vibrated packing is disordered. The distribution of strong forces follows the exponential law, while that of weak forces follows the power law. The static vertical stresses in both packings can be predicted by Janssen model. After vibration, a much denser and more stable structure with a larger saturation stress is obtained due to the reducing inter-particle friction effects.

Keywords: Packing densification; Cylindrical particles; Mechanical vibration; DEM simulation; Force/Stress analyses

* Corresponding author. Tel: +86-24-83689032; E-mail: anxz@mail.neu.edu.cn