Accepted Manuscript

GPU-based discrete element simulation on flow stability of flat-bottomed hopper

Li Peng, Zheng Zou, Libo Zhang, Qingshan Zhu, Hongzhong Li

PII: S1004-9541(17)30221-5
DOI: doi:10.1016/j.cjche.2017.07.021
Reference: CJCHE 897

To appear in:

Received date: 21 February 2017
Revised date: 27 July 2017
Accepted date: 29 July 2017

Please cite this article as: Li Peng, Zheng Zou, Libo Zhang, Qingshan Zhu, Hongzhong Li, GPU-based discrete element simulation on flow stability of flat-bottomed hopper, (2017), doi:10.1016/j.cjche.2017.07.021

Fluid Dynamics and Transport Phenomena

GPU-based discrete element simulation on flow stability of flat-bottomed hopper

Li Peng[a, b], Zheng Zou[a], Libo Zhang[a, b], Qingshan Zhu [a, b, *], Hongzhong Li[a, b, *]

[a] *State Key Laboratory of Multiphase Complex Systems, Institute of Process Engineering, Chinese Academy of Sciences, Beijing 100190, China*

[b] *University of Chinese Academy of Sciences, Beijing 100049, China*

E-mail: *hzli@ipe.ac.cn*

Abstract In this study, the flow stability of the flat-bottomed hopper was investigated via GPU-based discrete element method (DEM) simulation. With the material height inside the hopper reducing, the fluctuation of the flow rate indicates an unstable discharge. The flow regions of the unstable discharge were compared with that of the stable discharge, a key transformation zone, where the voidage showed the largest difference between unstable and stable discharge, was revealed. To identify the relevance of the key transformation zone and the hopper flow stability, the voidage variation of the key transformation zone with material height reducing was studied. A sharp increase in the voidage in the key transformation zone was considered to be the standard for judging the unstable hopper flow. And the 'Top-Bottom effect' of the hopper was defined, which indicated the hopper flow was unstable when the hopper only had the top area and the bottom area, because the voidage of particles in the top area and the bottom area were both variables.

Keywords: Stability; Discrete element modeling (DEM); Granular flow; Top-Bottom effect; Flow regions.

1. INTRODUCTION

Hoppers have been widely employed to deposit or recycle granular materials in many areas such as chemical, energy, and food industries. A main issue concerned in using hoppers is the presence of unstable flow, which has a marked influence on operational stability of units. It is therefore important to study the factors affecting hopper flow stability, and establish the standard for judging the unstable hopper flow for reliable design and operation of hoppers.

Actually, extensive studies have been performed to investigate the factors related to hopper flow stability, such as hopper pressure [1-3], hopper shapes [4, 5], wall properties [6-9], and particle