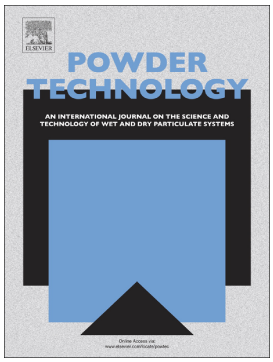

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PII: S0032-5910(18)30394-2
DOI: doi:10.1016/j.powtec.2018.05.024
Reference: PTEC 13397

To appear in: *Powder Technology*

Received date: 18 January 2018
Revised date: 3 May 2018
Accepted date: 11 May 2018

Please cite this article as: M. Sebastian Escotet-Espinoza, Charles J. Foster, Marianthi Ierapetritou , Discrete Element Modeling (DEM) for mixing of cohesive solids in rotating cylinders. The address for the corresponding author was captured as affiliation for all authors. Please check if appropriate. Ptec(2017), doi:10.1016/j.powtec.2018.05.024

Discrete Element Modeling (DEM) for Mixing of Cohesive Solids in Rotating Cylinders

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1. INTRODUCTION

Powders are key ingredients for manufacturing in pharmaceutical, petroleum, food, and other chemical industries. As much as sixty percent (60%) of all products are either sold or processed as a powder at some point during their manufacturing [1]. In the food and pharmaceutical industry, handling and mixing of powders plays a significant role in final product quality [3]. Despite the widespread use and production of powders in industrial processes, methods for characterizing the behavior of particulate systems are less advanced compared to those available for fluid systems [4, 5]. The lack in advancement has been attributed to the difficulty of characterizing powders in a class of materials (i.e., solids, liquids, or gases) because of their changing behavior and the complexity of mathematical modeling of particulate systems. A challenge faced by scientists and engineers is the characterization of bulk powder properties, which are subject to change throughout a process [6-8]. It is known that inter-particulate forces play a significant role in the behavior and flowability of particulate systems [9]. However, there is still lack of understanding of how inter-particulate forces affect particulate system behavior and whether or not such behavior can be predictively modeled with respect to inter-particulate forces. In the case of mixing processes, a fundamental understanding of the role of inter-particulate forces play in affecting mixing performance could lead to breakthrough in the predictive modeling of those processes.

Mixing is a critical unit operation in a variety of industries where product homogeneity is required [13]. In the food industry, product characteristics such as taste, quality, flavor, and texture can be impacted by mixture homogeneity [14]. In the heavily regulated pharmaceutical industry, small deviation