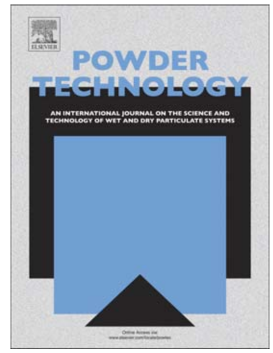
Accepted Manuscript



Numerical study of particle mixing in a lab-scale screw mixer using the discrete element method

Fenglei Qi, Theodore J. Heindel, Mark Mba Wright

PII: S0032-5910(16)30910-X
DOI: doi: 10.1016/j.powtec.2016.12.043
Reference: PTEC 12191

To appear in: *Powder Technology*

Received date: 12 October 2016
Revised date: 8 December 2016
Accepted date: 12 December 2016

Please cite this article as: Fenglei Qi, Theodore J. Heindel, Mark Mba Wright, Numerical study of particle mixing in a lab-scale screw mixer using the discrete element method, *Powder Technology* (2016), doi: 10.1016/j.powtec.2016.12.043

Numerical study of particle mixing in a lab-scale screw mixer using the discrete element method

Fenglei Qi[a], Theodore J. Heindel[a], Mark Mba Wright[a,*]

[a]*Department of Mechnical Engineering, Iowa State University, Ames, Iowa, 50010 USA*

Abstract

This study employs the Discrete Element Method (DEM) to simulate particulate flow and investigate mixing performance of a lab-scale double screw mixer. The simulation employs polydispersed biomass and glass bead particles based on experiments conducted in previous studies. Visual examination of particle distribution and statistical analysis of particle residence times of experimental data served as model validation. Statistical analysis indicates a maximum 9.8% difference between the experimental and simulated biomass particle mean residence time, and visual observations suggest the simulation captures the particle mixing trends observed in the experiments. Results indicate that the particle mean mixing time, non-dimensionalized by ideal flow time in the plug flow reactor, varies between 1.008 and 1.172, and it approaches 1 with increasing biomass feed rate. The mixing index profile in the axial direction shows a mixing-demixing-mixing oscillation pattern. Increasing screw pitch length is detrimental to mixing performance; decreasing the solid particle feed rate reduces the mixing degree; and increasing the biomass to glass bead size ratio decreases mixing performance. A comparison of a binary, single-sized biomass and glass particles mixture to a multicomponent mixture indicates that the binary system has similar mixing pattern as a multicomponent system. These findings demonstrate that DEM is a valuable tool for the design and simulation of double screw mixing systems.

Keywords:
Discrete element method; Double screw mixer; Mixing index; Multicomponent mixture; Particle mixing

1. Introduction

Screw conveyors/mixers are often used in solid handling processes in industries such as pharmaceutical production, food processing, mineral processing, construction and renewable energy production [1, 2, 3]. Usually single- or double-screws are installed in a housing, and the rotation of the screw(s) results in transportation and mixing of the solid bulk materials.

*Corresponding author
Email addresses: fqi@iastate.edu (Fenglei Qi), theindel@iastate.edu (Theodore J. Heindel), markmw@iastate.edu (Mark Mba Wright)