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Shahab Golshan, Reza Zarghami, Hamid Reza Norouzi, Navid Mostoufi

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Granular Mixing in Nauta Blenders

Shahab Golshan, Reza Zarghami*, Hamid Reza Norouzi and Navid Mostoufi

Process Design and Simulation Research Centre, School of Chemical Engineering, College of Engineering, University of Tehran, P.O. Box 11155/4563, Tehran, Iran

Abstract

Flow pattern of particles and their mixing performance in a Nauta blender were studied using the discrete element method. The model was validated by experimental data obtained in a convective conical screw blender and good agreement was obtained. Flow pattern of particles was studied through velocity profiles, granular temperature and streamlines of particles. Effects of sweeping rotation speed, primary rotation speed and impeller diameter on the mixing quality and mixing rate were studied. A vertical circulation pattern in the blender was observed due to the primary rotation of the impeller that produced a convective and layered flow. In this pattern, particles are lifted to the bed surface and then descend at the opposite side of the screw. On the other hand, the sweeping rotation of the impeller pushes the particles along the direction of sweeping which leads to a tangential flow of particles. Combination of primary and sweeping rotations of the impeller results in a three dimensional particle mixing. A semi-stagnant zone is also formed temporarily near the cone axis. It was found that increasing the primary rotation speed (from 5 to 10 rad/s) and impeller diameter (from 9.72 to 10.8 cm) improve the mixing rate (from 0.02096 to 0.0532 1/s and from 0.02462 to 0.03465 1/s, respectively), while increasing the sweeping rotation speed (from 0.15 to 0.45 rad/s) decreases the Lacey index and the mixing rate (from 0.04429 to 0.0313 1/s). To reach a deeper understanding about the effect of sweeping rotation on the mixing

* Corresponding author, Tel.: (+98-21)6696-7797, Fax: (+98-21)6646-1024, E-mail: rzarghami@ut.ac.ir