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Yuyun Bao, Yu Lu, Ziqi Cai, Zhengming Gao

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Effects of rotational speed and fill level on particles mixing in a stirred tank with different impellers

Yuyun Bao, **Yu** Lu, **Ziqi** Cai* , **Zhengming** Gao

State Key Laboratory of Chemical Resource Engineering, School of Chemical Engineering, Beijing University of Chemical Technology, Beijing 100029, China

*Corresponding author. Email: caiziqi@mail.buct.edu.cn(Z.Q. Cai)

Abstract The particles mixing was studied in a cylindrical stirred tank with elliptical dished bottom by experiments and simulations. The impeller types used were double helical ribbon (HR)+bottom HR, pitched blade ribbon+bottom HR, inner and outer HR+bottom HR, and pitched blade ribbon+Pfaudler+bottom HR labeled as impellers I to IV, respectively. The quantitative correlations among the rotational speed, fill level and power consumption for impeller I and impeller II were obtained by experiments to validate the discrete element method (DEM) simulations. The particles mixing at different operating conditions was simulated via DEM simulations to calculate the mixing index using the Lacey method, which is a statistical method to provide a mathematical understanding of the mixing state in a binary mixture. The simulation results reveal that as the rotational speed increases, the final mixing index increases, and as the fill level increases, the final mixing index decreases. At the same operating conditions, impeller III is the optimal combination, which provides the highest mixing index at the same revolutions.

Keywords particle, mixing, discrete element method (DEM), rotational speed, fill level, Lacey index

1 INTRODUCTION

Particles mixing is widely used in the pharmaceutical processes [1], chemical engineering [2], food processing [3], metallurgy [4], *etc*. The mixing performance, which is usually characterized by the degree of mixing, is of paramount importance to the quality of products in industrial processes. The particles mixing degree is mostly evaluated by sampling in the experiments [5]. Previous researchers have investigated particles mixing at different operating conditions by experimental methods. Brone *et al*. [6] and Simons *et al*. [7] studied the effect of rotational speed,