

# Accepted Manuscript

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PII: S0032-5910(18)30811-8  
DOI: doi:[10.1016/j.powtec.2018.09.077](https://doi.org/10.1016/j.powtec.2018.09.077)  
Reference: PTEC 13751  
To appear in: *Powder Technology*  
Received date: 23 February 2018  
Revised date: 25 September 2018  
Accepted date: 26 September 2018

Please cite this article as: Li Li, Ping Wu, Shiping Zhang, Li Wang , Vertical separation criterion of binary particles under external excitation. Ptec (2018), doi:[10.1016/j.powtec.2018.09.077](https://doi.org/10.1016/j.powtec.2018.09.077)

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## Vertical separation criterion of binary particles under external excitation

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### Abstract

Vertical separation occurs in the binary granular system and varies with most factors of external excitation and particle properties, that is complex to explain and predict. We propose that it can be discussed from two aspects: 1) the influence of the specific external-excitation condition and 2) the separation response of the system itself. Based on the percolation and filling behaviors of particles, a vertical separation criterion is presented to discuss the above two aspects with vibration frequency  $f$ , dimensionless vibration acceleration  $\Gamma$ , airflow velocity  $u$ , particle size ratio  $\varphi_d$ , density ratio  $\varphi_\rho$  and total mass ratio  $\varphi_M$  when the container size and the granular system's packing height are fixed. In our criterion, Brazil nut separation (BN, large particles rise to the top), reverse Brazil nut separation (RBN, large particles sink to the bottom), and their crossover line (It can present as a MIX distribution where particles mix uniformly) are discussed. It's found that the system with strong separation response (a low  $\varphi_M/\varphi_d^3\varphi_\rho$ ) tends to show a strong BN or RBN separation under appropriate conditions of vibration and/or airflow. Conversely, the system with weak separation response (a high  $\varphi_M/\varphi_d^3\varphi_\rho$ ) inclines to separate weakly or mix uniformly.

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