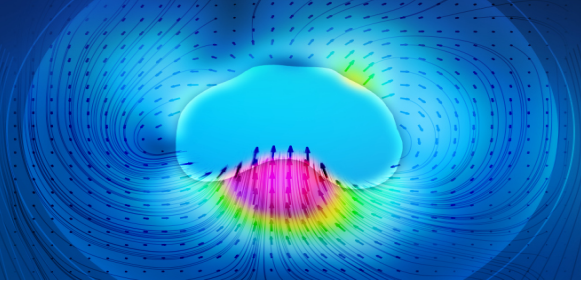
TUHH Hamburg University of Technology

Institute of Process Imaging



21.02.2025

Project work / Bachelor's thesis / Master's thesis

Determination of the minimum fluidization velocity in vibrated bubbling gas-solid fluidized beds

Motivation:

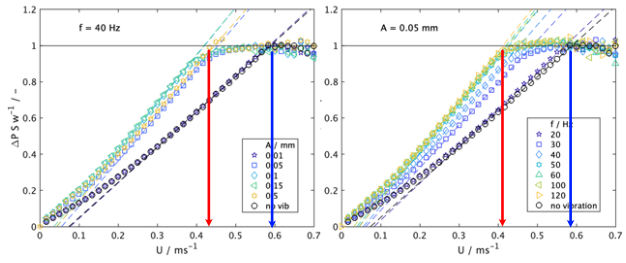
Gas-solid fluidized beds are widely used in various process engineering applications, including pharmaceutical production, mixing,drying and energy conversion. Fluidized beds offer high solid-gas contact, which promotes enhanced heat and mass transfer rates, making them a favorable choice for many processes. Mechanical vibration can further improve the performance of fluidized beds. For instance, by preventing agglomeration and channeling in Geldart Group A and C particles while initiating fluidization [1] and enhancing heat transfer during the drying process [2].

The minimum fluidization velocity is the velocity required to transition the bed from a static state to a fluidized state. Previous studies have demonstrated that mechanical vibration reduces both the minimum fluidization velocity [3-4]. In this study, the impact of mechanical vibration on minimum fluidization velocity will be investigated in three-dimensional gas-solid fluidized beds under various vibration conditions and for different types of particles. The experiments will be conducted using two different experimental setups to examine the effect of bed geometries. Finally, the collected data will be used to derive an equation for estimating the minimum fluidization velocity in vibrated fluidized beds.

Tasks:

- Literature review on vibrated gas-solid fluidized beds and the impact of vibration on minimum fluidization velocity.
- Writing a script to collect pressure data from an analog sensor while simultaneously changing the gas volumetric flow rate.
- Measuring the minimum fluidization velocity in three-dimensional (3D) gas-solid fluidized beds of different sizes.
- Investigating the minimum fluidization velocity for different types of particles.
- Deriving an empirical correlation from experimental data to determine the minimum fluidization velocity for vibrated fluidized beds.

(a)



(a) Constant frequency. (b) Constant amplitude.

(b)

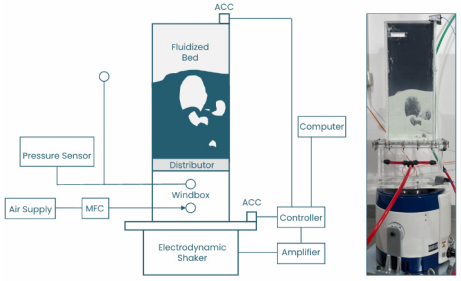


Figure 1: (a) Reduction of the minimum fluidization velocity (umf) under different vibration conditions. The figure on the left shows the reduction of u_{mf} at a constant vibration frequency while varying the vibration amplitude. It can be seen that umf in the non-vibrated bed (blue line) is higher than in the vibrated bed (red line). The figure on the right demonstrates a similar behavior at a constant vibration amplitude but different vibration frequencies. The preliminary experiments were performed in a pseudo-two-dimensional bed. (b) Experimental setup. An electrodynamic shaker is used to generate sinusoidal acceleration.

Your profile:

Ideally, experimental work experience and programming with Python.

Starting date: March 2025

Contact person: Melis Özdemir, melis.oezdemir@tuhh.de, Tel: +49 40 42878 3124, Building L, Room 3.014

Other projects involving vibrated fluidized beds are available for Master's theses, Bachelor's theses, and project work. Feel free to contact for further information.

[1] Xu, C.; Zhu, J. Experimental and Theoretical Study on the Agglomeration Arising from Fluidization of Cohesive Particles—Effects of Mechanical Vibration. Chemical Engineering Science 2005, 60 (23), 6529–6541. https://doi.org/10.1016/j.ces.2005.05.062. [2] Guo, Q.; Spitler, C.; Sanghishetty, J. M.; Boyce, C. M. Advances in Vibrated Gas-Fluidized Beds. Current Opinion in Chemical Engineering 2023, 42, 100977. https://doi.org/10.1016/j.coche.2023.100977. [3] McLaren, C. P.; Metzger, J. P.; Boyce, C. M.; Müller, C. R. Reduction in Minimum Fluidization Velocity and Minimum Bubbling Velocity in Gas-Solid Fluidized Beds Due to Vibration. Powder Technology 2021, 382, 566–572. https://doi.org/10.1016/j.powtec.2021.01.023. [4] Mawatari, Y.; Tatemoto, Y.; Noda, K. Prediction of Minimum Fluidization Velocity for Vibrated Fluidized Bed. Powder Technology 2003, 131 (1), 66–70. https://doi.org/10.1016/S0032-5910(02)00323-6.

https://www.ipi.tuhh.de/