08.03.2024

Bachelor's thesis / Master's thesis

Dynamically structured bubbling in gas-solid fluidized beds

Motivation:

Increased heat and mass transfer due to an intense solid-fluid contact in fluidized beds makes them a favorable choice in many processes such as drying, mixing, catalytic reactions, particle coating and agglomeration. Even though fluidized beds are widely used, our understanding of their complex hydrodynamics is still limited. Due to their intricate nature, a gas-solid fluidized bed is often seen as an idealized suspension facing instability, or characterized as a deterministic chaotic system, where minor disturbances, like fluctuations in the fluid stream, might evolve into entirely different hydrodynamics [1]. Therefore, predicting the system behavior poses a challenge, leading to difficulties in process intensification and control. Normally chaotic motion of bubbles in fluidized beds could be turned into a more structured, predictable pattern via certain methods such as mechanical vibration, oscillating gas flow and internals (Fig. 1a) [2]. In structured bubbling , the bubbles become smaller, distributing more uniformly throughout the bed and following a specific arrangement (Fig. 1b). This allows for the anticipation of the flow pattern within the system. Structured bubbling shows promise for enhancing performance while also facilitating improved control and scalability in industrial applications [1].

Tasks:

- Literature review on methods for creating structured bubbling and patterns in granular media.
- Investigation of dynamically structured bubbling in a mechanically vibrated pseudo-2D fluidized bed.
- Investigation of the impact of particle properties and gas distributors on fluidized bed hydrodynamics and structured bubbling.
- Investigation of bubble characteristics using a high-speed camera and performing image analysis with Python.

Your profile:

- Ideally, experimental work experience, basic knowledge of image processing and programming with Python.

Starting date:

- April 2024

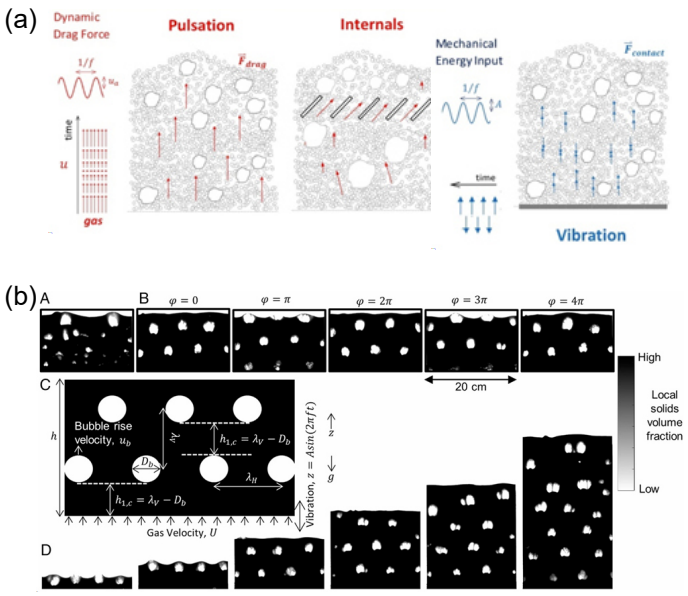

Figure 1: (a) Various methods for achieving structured bubbling in gas-solid fluidized beds. [1] (b) Dynamically structured bubbling induced by vibration. Figure A illustrates bubbling without vibration, while Figure B demonstrates bubbles rising in a regularly spaced triangular arrangement without coalescing or splitting under vibration. This arrangement repeats itself every two vibration cycles. Figure C shows the key parameters for image analysis, and Figure D shows that the structuring persists as the bed height increases. [2]

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.

Contact person:

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[1] Francia, V.; Wu, K.; Coppens, M.-O. Dynamically Structured Fluidization: Oscillating the Gas Flow and Other Opportunities to Intensify Gas-Solid Fluidized Bed Operation. Chemical Engineering and Processing - Process Intensification 2021, 159, 108143. https://doi.org/10.1016/j.cep.2020.108143. [2] Guo, Q.; Zhang, Y.; Padash, A.; Xi, K.; Kovar, T. M.; Boyce, C. M. Dynamically Structured Bubbling in Vibrated Gas-Fluidized Granular Materials. Proc. Natl. Acad. Sci. U.S.A. 2021, 118 (35), e2108647118. https://doi.org/10.1073/pnas.2108647118.