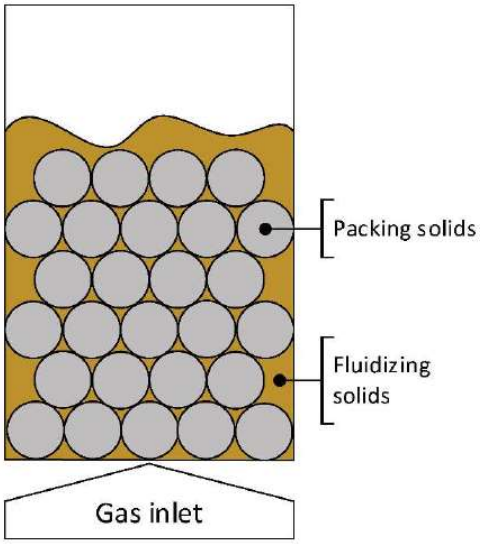
Characterization of slugging and solids through-flow in packed-fluidized bed

We are looking for 1-2 students to conduct a MSc project within the field of energy technology. The project would probably be most suitable students with background in chemical or mechanical engineering, but students with other backgrounds could also work well.

In a fluidized bed, a two-phase gas-solids system is made to behave almost analogous to a gas-liquid system. This is achieved by adding the gas in a controlled manner from the bottom of a bed of solid particles, with sufficiently high velocity so that the drag force lifting the particles upwards exceeds the gravity force pulling them downwards. The most important characteristics of fluidized bed reactors are their ability to promote extremely high levels of contact between gases and solids per unit bed volume and very rapid heat transfer. Fluidized-bed reactors are currently is used in many processes that relies on interaction between solids and fluids (e.g. combustion, gasification, heterogeneous catalysis, chemical looping combustion, adsorption, drying, heating, cooling).

Packed-fluidized bed is a novel concept currently being investigated at Chalmers. A packing material (e.g. spheres, tubes) of much larger size than the fluidized particles are added to the system. The packing material self-organizes into a stacked lattice from the bottom of the reactor and upwards (or as a floating plug at the top of the reactor), with fluidization of the particulate bed material occurring in the packing voids.



This arrangement has a number of potential advantages. Notably, the packing restricts bubble growth which improves gas-solid mass transfer. Another problematic aspect that can arise from bubble growth in deep fluidized beds is slugging, by which is meant bubbles growing so big that they almost cover the entire cross-section of the reactor. Slugging greatly reduces gas-solid mass transfer and also induce potentially serious practical problems such as vibrations and noise.

We have recently performed experimental studies about various aspects of fundamental fluidization properties (gas-solid mass transfer, pressure drop, solids through-flow, heat transfer) for packed-fluidized beds, resulting in several scientific papers and reports. The proposed project involves follow-up and continuation of this effort. ***Detailed characterization of slugging, and inhibition thereof, by use of random packing with high void factor is one topic that would be exiting to examine closely. Solids through-flow of particles for packed-fluidized bed with such evolved packing material is another topic that could be considered.*** These phenomena can be studied experimentally in plexiglas cold-flow fluidized-bed reactor. The project will utilize a proven reactor setups and methods previously used for other kinds of fluidization experiments.

Random packings with high void factor. Thread saddle (top) and pall ring (bottom)

The project will be performed at the Division of Energy Technology at Chalmers. It is associated with of an ongoing Swedish Research Council project about the use of packed-fluidized beds in energy conversion applications. The larger context of the work of the hosting research group is the development of novel and improved fluidized-bed processes for combustion, gasification and CO_2 capture, predominantly from biomass fuels. Many of our current projects focuses on CO_2 capture during biomass utilization, with would allow for climate mitigation by extraction of CO_2 from the atmosphere (so called negative CO_2 emissions).

About the possibility to do a 60 HEC MSc thesis: A typical master thesis at Chalmers encompasses 30 HEC. It is possible to make an extended thesis of 60 HEC, reducing the course requirements with 30 HEC. Our group is restrictive with this opportunity but will consider it for highly motivated students with above average marks. The expectation on a 60 HEC MSc is a significant increase in the scope of the work, an honest interest in academic research and the ambition to reach a level that would allow for publication of the work in a scientific journal.

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