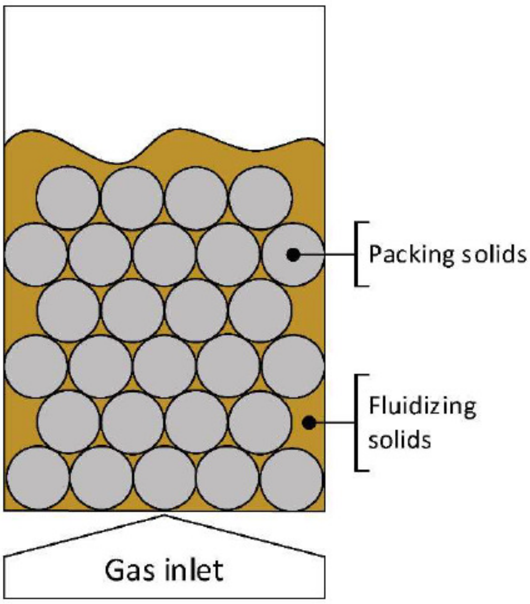
Measuring of heat transfer coefficient to tube reactor submerged in a packed-fluidized bed

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 a students with background in chemical or mechanical engineering, but students with other backgrounds will also be considered.

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 beds is an important technology that 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).

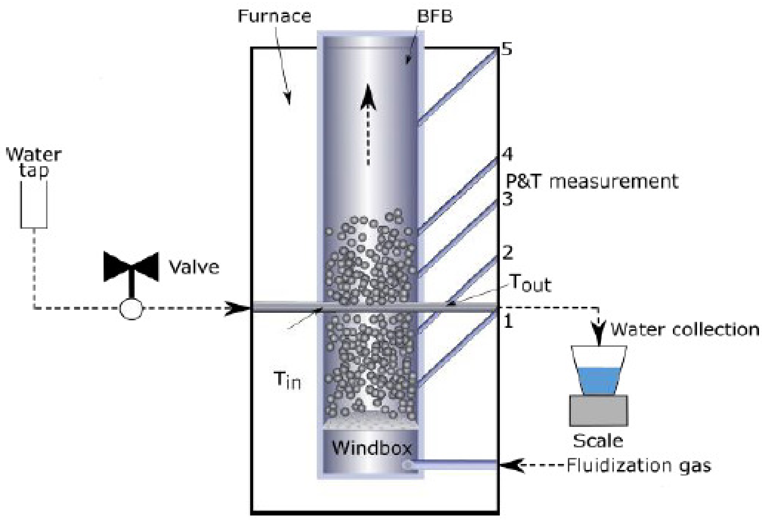
Packed-fluidized bed is a novel concept currently being investigated at Chalmers. A packing material (e.g. spheres, tubes) of much larger size than the fluidized particles are added to the system. The packing material self-organizes into a stacked lattice from the bottom of the reactor and upwards, with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



This arrangement has a number of potential advantages, notably improved gas-solid mass transfer due to strict limitations on bubble growth.

The proposed project involves experimental determination of heat transfer coefficient to the surface of a tube reactor submerged in a packed fluidized bed at temperatures up to 1000°C. Currently, very limited amounts of heat transfer data is available for packed-fluidized beds and nothing at elevated temperatures.

The project will utilize a reactor setup previously used for heat transfer measurements in fluidized beds without packing material. It consists of a vertical tube located inside a bubbling fluidized bed reactor of high temperature steel (see the figure to the right). A previous master thesis project that utilized this reactor setup (http://publications.lib.chalmers.se/records/fulltext/255931/255931.pdf) was quite successful and resulted in a peer-reviewed publication (to be published during 2019):



The project will be performed at the Division of Energy Technology at Chalmers. It is part of an ongoing Swedish Research Council project about 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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