Copper smelter slag as chemically active bed material in fluidized-bed combustion and related processes for CO_2 mitigation

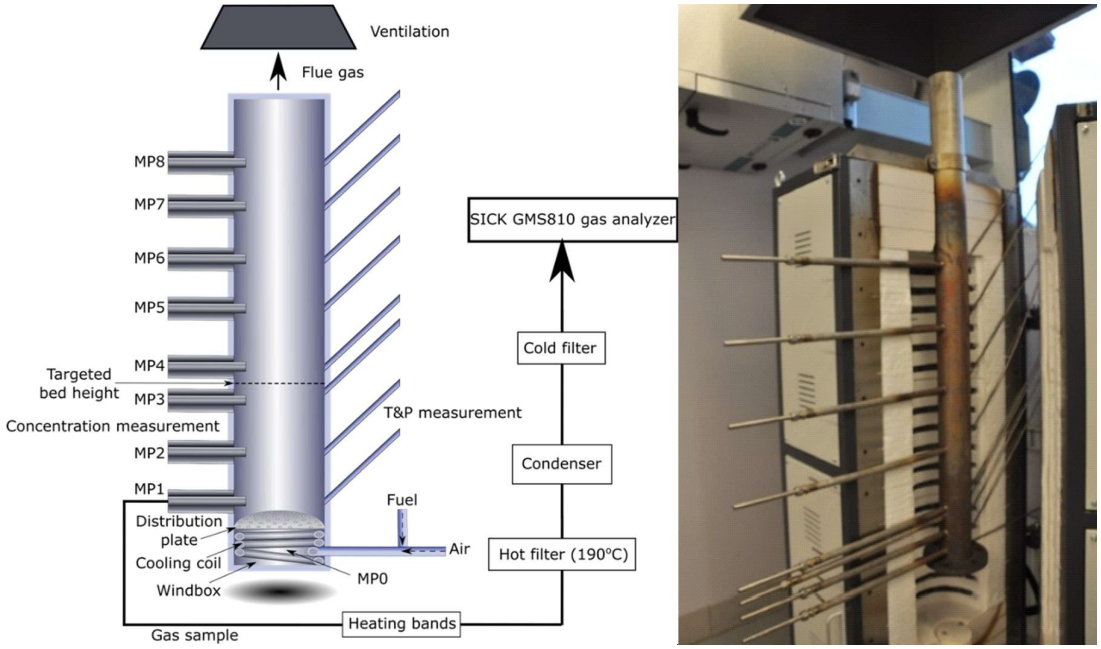
We are looking for 1-2 students to conduct a MSc project within the field of energy technology. The project would probably be most suitable a students with background in chemical engineering, but students with other backgrounds will also be considered.

Fluidized beds are currently used in many industrial processes that relies on interaction between solids and fluids (e.g. combustion, gasification, heterogeneous catalysis, chemical-looping combustion, adsorption, drying, heating, cooling). A large industrial application in Sweden is fluidized-bed combustion of biomass and waste fuels. In combustion the common choice for bed material is silica sand, which however has a number of know drawbacks. Presently, there is a surge in interest for using alternative bed materials.

The use of industrial by-products such as slag from the mining industry is economically attractive and also has potential to contribute towards the circular economy. Further, the use of bed materials that contains certain transition metal oxides (e.g. Fe, Mn, Cu) are of particular interest. Such materials are referred to as oxygen carriers, since they are capable of interacting with fuel and oxygen. In fuel rich zones the metal oxides will be reduced, while it will be oxidized in zones rich with air. The net effect would be improved mixing of fuel and oxygen both in the space and the time dimension. The concept is invented at Chalmers and typically referred to as Oxygen Carrier Aided Combustion (OCAC). We are currently working with several companies that are interested in this concept, notably E.ON which has founded a subsidy for commercialization (https://www.improbed.com/). We are also developing a novel fluidized-bed combustion process with inherent CO2 sequestration based on oxygen carriers called Chemical-Looping Combustion (CLC).

The goal of this project is to evaluate the properties of copper smelter slag, so called iron sands as bed material and oxygen carrier for Oxygen Carrier Aided Combustion (OCAC) and Chemical-Looping Combustion (CLC). Iron sand is a by-product generated in the Boliden Rönnskär smelter in Sollefteå during production of copper, zinc, lead, silver and gold. In the process silica sand is added as flux, which bonds with iron and make extraction of the more valuable metals possible. Iron sand comes directly as hard particles suitable for use in fluidized beds and consists of mostly iron and silica oxides, with traces of other elements. The annual production is more than 300 000 tons per year, for which there is no application aside for local low-value use in construction masses.

In the project, iron sand will be examined in combustion experiments in lab reactor. We have great experience of this kind of work and the reactor system involved have been proven in similar studies. Fresh and used bed material may be characterized by other means as well, for example with respect to chemical and mechanical properties.



Experimental reactor for CLC and OCAC experiments at Energy Technology.

The project will be performed at the Division of Energy Technology at Chalmers. It is part of an ongoing Swedish Research Council project about Oxygen Carrier Aided Combustion (OCAC) and industrial cooperation with several partners. 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.

Contact persons:
Magnus Rydén (magnus.ryden@chalmers.se, +46 (0)31 772 1457
Felica Störner (felicia.storner@chalmers.se, +46 (0)31 772 1428