Chemical looping gasification of Low-Grade, High-Volatile and CaCO3-Content Fuel and biomass

Summary

The overall goal of the project is to investigate and develop a chemical looping gasification (CLG) process as a novel CO2 capture technology for the thermochemical valorization of oil shale and biomass (including wood waste) into raw materials for the chemical industry and building materials with simultaneous energy production. More specifically, this project will explore ways to maximize the value of oil shale and biomass in a waste-free and climate-neutral way. The aim of the project is to produce gaseous H2 rich or directly high purity H2 products and ash suitable for the cement industry. The characteristic of the CLG process is the CO2 neutral H2 rich syngas production at low specific costs (no air separation unit required) and high efficiency. The use of oil shale as a feedstock can allow an additional process stream to be achieved in the form of CO2 neutral ash used as a cement additive. CLG can be capable of producing carbon-negative hydrogen when carbon-neutral biomass is used as feedstock.

Research field:	Chemical, materials and energy technology
Supervisors:	Prof. Dr. Alar Konist Dmitri Nešumajev
Availability:	This position is available.
Offered by:	School of Engineering Department of Energy Technology
Application deadline:	Applications are accepted between June 01, 2024 00:00 and June 30, 2024 23:59 (Europe/Zurich)

Description

One of the promising technologies in the emerging carbon capture and storage (CCS) family is chemical looping (CL), which is characterized by lower cost and energy use per tonne of CO2 captured, as there is no need for air separation equipment (at least full scale) compared to competing technologies. The key concept of the CL cycle is that the fuel does not have to react directly with the air. Instead, the oxygen in the air is delivered to the 'fuel reactor' by means of a solid oxygen carrier (OC) (usually active solid metal oxide MxOy). Oxygen regeneration can be achieved through the use of air or steam (in case of H_2 production). To date, different chemical looping processes have been proposed. One of the crucial elements of the SLG process is the oxygen carrier, which must fulfill various requirements, including lifetime, oxygen carrying capacity, sintering and agglomeration tendency, deterioration of reactivity and etc during cyclic operation. Recently, it has been shown that the composition of CaO-based sorbents with active metal-based materials (CuO, Fe2O3) can demonstrate even better performance due to the synergistic effects.

The aim of this PhD project is to analyze and investigate the viability of a novel gasification process for the valorisation of local natural and waste resources (oil shale, biomass) for syngas and high yield and purity H2 production.

Responsibilities and specific tasks

- Modelling and simulation of the full chain different CLG processes using Aspen plus to evaluate and compare various configurations, feedstock types and oxygen carriers.
- Characterization of oxygen carriers (based on lab scale experiments and thermodynamic modelling) in terms of identifying the preferred one in its specific application with domestic feedstock.
- Studying the effects of different parameters on SLG process in terms of its performance (product yield, purity, economic and thermal efficiency)
- Contributing to analyzing, publishing and dissemination of the results of the study as a member of the research team.

Applicants should fulfil the following requirements:

- a master’s degree in energy/chemical/mechanical technology;
- a clear interest in the topic of the position;
- excellent command of English;

- strong and demonstrable writing and analytical skills;
- capacity to work both as an independent researcher and as part of the research team;
- capacity and willingness to provide assistance in organizational tasks relevant to the project and teaching and/ or supervision activities.

The following experience is beneficial:

- knowledge of modelling and simulations processes using Aspen;
- knowledge of gasification/combustion technologies.
- Programming skills.

We offer:

• 4-year PhD and early-stage researcher position in internationally recognized research team of Energy technology.

• Opportunities for conference visits, research stays and networking with globally leading universities and research centers in the field of biopolymer technology.

About the laboratory

Activities:

• conducting studies at the bachelor's, master's and doctoral level;

• conducting basic and applied research in the field of polymeric materials, biopolymers;

Additional information

For further information, please contact Prof. Alar Konist Alar.Konist@taltech.ee

To get more information or to apply online, visit https://taltech.glowbase.com/positions/777 or scan the the code on the left with your smartphone.