Conversion of oil shale industry by-products into cementitious materials

Summary

This topic will focus on enhancing the formation of CSA clinker minerals synthesized from natural raw materials and industrial waste products. Aim is to enhance the reactivity and hydraulic activation by other mineral compounds in different aluminate blends, which is the key in developing new low energy and low GHG based cement production.

Research field:	Chemical, materials and energy technology
Supervisors:	Prof. Dr. Alar Konist Dr. Kadriann Tamm
Availability:	This position is available.
Offered by:	School of Engineering Department of Energy Technology
Application deadline:	Applications are accepted between January 01, 2025 00:00 and January 24, 2025 23:59 (Europe/Zurich)

Description

The European Union (EU) has set a highly ambitious goal to reach climate neutrality by the 2050, which means that the plan to move towards climate neutrality must be based on scientifically sound choices.
The largest source of CO2 emissions is energy sector, where transformation that is steadily transforming to the green energy. In order to achieve climate neutrality, anthropogenic CO2 sources must be eliminated in other sectors as well. Among these sectors is the cement industry, which is one of the largest CO2 emitters because it is used for production of concrete that is the most used manufactured material in the world. Most of the cement's emissions result from production of Portland cement clinker, which is the main cement component.

Current annual global cement production is about 4.1 Gt. It is estimated that the global cement production will increase to over 5 Gt year by 2050. Thus, it can be concluded that the cement industry is significantly expanding when at the same time its emissions need to be cut fast. To achieve this the following solutions for cutting CO2 emissions have been proposed:

- Increasing resource usage efficiency by reducing the clinker-to-cement ratio;
- Increasing energy efficiency of plants;
- Replacing fossil fuels with renewables
- Deploying innovative technologies (including CCUS);
- Developing less energy intensive, lower emission cements.

Clinker-to-cement ratio can be modified by substituting the clinker in cement mixtures with secondary cementitious materials which are often industrial by-products. Further, recent blended cement developments have shown that up to 50% clinker displacement is possible through optimised combinations of calcined clay and ground limestone as cement constituents without affecting cement properties. For diminishing energy consumption, grinding additives, along with improvements in combustion, heat exchange and grinding technologies have been applied. The array of fuels used for replacing fossil fuels is diverse, ranging from rice husks to wastes. Also, different carbon capture technologies have already been applied on a pilot scale. Among proposed solutions, the approach of replacing conventional Portland cement with low emission (or low-carbon) cements, referred to as green cements, is perhaps the most revolutionary as these rely on different raw materials or their mixes. On the other hand, it is evident that more research activities are needed in this field to achieve climate goals.

Aim of PhD studies is to find a solution for producing CSA clinker at temperatures below 1000 °C using Oil Shale industry ash in combiantion with different additives/materials.

Responsibilities and (foreseen) tasks:

- Prepare a research plan with the help of the supervisor and carry out research according to the plan.

- Working with literature
- Design of experiments and experimental setups
- Giving recommendations for better organization of work
- Collaboration with other PhD students and colleagues in the department
- Supervision of BSc and MSc students
- Conduct necessary laboratory experiments.
- The PhD student will work closely with collaborators from TalTech and abroad (e.g. USA) and will be expected to participate in relevant national and international conferences, and develop journal papers within the research field.

Applicants should fulfil the following requirements:

- A master's degree in thermal, chemical or mechanical engineering
- Good speaking and writing English.
- a clear interest in the topic of the position
- strong and demonstrable writing and analytical skills
- capacity to work both as an independent researcher and as part of an international team
- capacity and willingness to provide assistance in organizational tasks relevant to the project

The following experience is beneficial:

- Programming in Python
- Knowing SimaPro, Aspen, etc
- Practical experience with analytical apparatus, e.g. TGA analysis
- Previous participation in research projects

We offer:

- 4-year PhD position in the Department of Energy Technology in Tallinn University of Technology
- The chance to focus on a high-level research
- Opportunities for conference visits, research stays and networking
- In case of interest, the opportunity to participate in other project applications and projects

About the department

The Department of Energy Technology is a research-oriented department that has also strong connections with Estonian chemical industry and heat and power industry. The topics covered include chemical engineering, environmental engineering, thermal engineering, thermal power plants, heat economy and thermal energy.

Additional information

For further information, please contact Professor Alar Konist alar.konist@taltech.ee or visit

https://taltech.ee/en/department-energy-technology

To get more information or to apply online, visit https://taltech.glowbase.com/positions/911 or scan the the code on the left with your smartphone.