

Retrofitting existing fossil fuel-fired CFB boiler with a high-temperature thermal energy storage

Summary

Retrofitting existing fossil-fired fluidized bed power plants with high-temperature thermal energy storage systems is a promising approach for the flexible CO₂-free provision of electricity and heat. This however, requires the modification of the existing fossil-fired fluidized bed power plants to be identified. The best approach for identification of the necessary modifications is to use the numerical methods, including computational fluid dynamics (CFD) and semi-empirical dynamic models based on the 1.5-D approach. The main aim of the PhD project is to develop different numerical models and validate these models using experimental data. The PhD project is supervised by Senior Researcher Dmitri Nešumajev and co-supervised by Professor Oliver Järvik (Department of Energy Technology, Tallinn University of Technology, Estonia).

Research field:	Chemical, materials and energy technology
Supervisors:	Dmitri Nešumajev Dr. Oliver Järvik
Availability:	This position is available.
Offered by:	School of Engineering Department of Energy Technology
Application deadline:	Applications are accepted between June 01, 2025 00:00 and June 30, 2025 23:59 (Europe/Zurich)

Description

The research

A promising approach for redeployment existing and decommissioned fluidized-bed combustion (CFBC) power units operating on solid fossil fuels – but which have not yet reached the end of their operational lifetime – is their retrofit into high-temperature thermal energy storage (HT-TES) systems. One of the key objectives is to evaluate the efficiency and necessary modifications of existing circulating fluidized bed (CFB) boilers and units, as the heat source will undergo a fundamental change. According to this concept, the heat source will be hot air supplied from a high-temperature thermal energy storage system. The aim of this PhD project is to analyse the performance of circulating fluidized bed (CFB) systems using numerical methods, including computational fluid dynamics (CFD) and semi-empirical dynamic models based on the 1.5-D approach, across different scales.

Key responsibilities and (foreseen) tasks

- Numerical simulation of two-phase flow in CFB systems at different scales using CFD codes.
- Develop a dynamic process simulation model of a circulating fluidized bed (CFB) power unit, incorporating all major components, using a semi-empirical 1.5D modelling approach.
- Contributing to analysing, publishing and dissemination of the results of the study as a member of the research team.
- Publication of research results in high-impact journals and presentation at international conferences.
- Supervision of BSc and MSc students.

Applicants should fulfil the following requirements:

- A master's degree in thermal engineering, chemical engineering, mechanical engineering or other engineering subjects related to the PhD project topic.
- A clear interest in the topic of the position.
- Proficient in modelling and simulations of energy/chemical/mechanical processes using CFD.
- Strong written and verbal communication skills in English.
- 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.

- Programming skills.

Applicants should submit:

- A cover letter outlining the motivation and relevant experience.
- A research plan for the topic, including the overall research and data collection strategy.
- Possible titles of at least three articles to be published on the project topic.
- Previous work (e.g. thesis/dissertation, scientific articles, conference communications) that demonstrate proficiency in the PhD topic.

We offer:

- 4-year PhD position in the Department of Energy Technology in Tallinn University of Technology.
- A stimulating research environment with access to state-of-the-art facilities.
- Opportunities for professional development and networking.
- Full-time paid employment with competitive salary and benefits.
- Support for conference travel and research dissemination.

About the department

The Department of Energy Technology is a research-focused department with robust connections to the Estonian chemical industry as well as the heat and power sectors. Our areas of expertise encompass chemical engineering, environmental engineering, thermal engineering, thermal power plants, heat economy, and thermal energy.

Additional information

For further information, please contact Dr. Dmitri Nešumajev (dmitri.nesumajev@taltech.ee) or Prof. Oliver Järvik (oliver.jarvik@taltech.ee).



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