# Co-pyrolysis of biomass and oil shale

## Summary


*PhD position in Mechanical Engineering, with the field of Thermal Power Engineering*

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| Research field: | Mechanical engineering |
| Supervisors: | Prof. Dr. Alar Konist<br>Heidi Lees |
| Availability: | This position is available. |
| Offered by: | School of Engineering<br>Department of Energy Technology |
| Application deadline: | Applications are accepted between June 01, 2020 00:00 and July 03, 2020 23:59 (Europe/Zurich) |


## Description

Global climate concern and the increasing demands for energy have spurred much research into alternative energy sources throughout the world. Oil shale, a sedimentary rock with organic matter called kerogen, has great potential for future applications because of its large reserves. Therefore, oil shale can be considered as one of the most important potential substitute resources for petroleum. Moreover, as a renewable energy, biomass has also attracted increasing attention, because of its availability in large quantities in many regions and great potential to play an important role in the energy field.  Biomass is an important source of energy and fuels to achieve the goal set by the EU to reduce the GHG emissions by 2050 to reach CO2 neutrality also known as EU Green Deal. Currently the main biomass utilization routes are either biogas production or its combustion. An alternative to these processes is biomass thermal treatment by pyrolysis, which unlike, for example, biogas production, can be carried out regardless of biomass composition. Biomass is relatively cleaner than coal and is the only renewable carbon resource that can be directly converted into fuel. Biomass can significantly contribute to the world's energy needs if harnessed sustainably. However, there are also problems associated with the thermal conversion of biomass.

During retorting, the kerogen in oil shale is first converted into critical organic intermediates (i.e., pyrolytic bitumen) at temperatures of about 350°C, releasing some small molecular substances such as moisture, interlayer water, and CO2. As the temperature continues to rise, the bitumen is further decomposed and evaporated, generating gases, shale oil, and coke in the temperature range of 400−550°C. For the pyrolysis of most types of biomass, bio-oil, synthetic gases, and semi coke are usually formed at temperatures below 400°C.

Unlike shale oil, bio-oil is lighter and contains more oxygenated compounds. Co-pyrolysis systems have been employed by many researchers to investigate the interactions between two types of fuels, such as coal and biomass. Unfortunately, the pyrolysis characteristics of oil shale − biomass blends have rarely been researched. Although some researchers have explored the individual pyrolysis processes of oil shale and biomass. Compared with coal, oil shale contains more aliphatic hydrocarbons such as longer straight chains and fewer aromatic hydrocarbons. In addition, the thermal conversion process of kerogen to bitumen in oil shale occurs in almost the same temperature range as the decomposition of biomass.

During the co-pyrolysis, the oil shale influences the distribution of the oxygen content in the biomass products, causing an increase of CO2 and CO in the gaseous products and are reduction of oxygen-containing compounds such as alcohols, aldehydes, lipids, and ethers in the liquid products.

Therefore, it is highly desirable to investigate the co-pyrolytic behavior of these two fuels. Usually, pyrolysis processes of carbonaceous materials can be considered as independent processes for producing various fuels, and the yields and quality of shale oil are limited by its own H/C ratio. The presence of biomass might influence or even improve the quality of shale oil.

The results could be utilized to forecast the pyrolytic behavior of oil shale and biomass blends for the proper design of industrial thermal conversion systems.

For the analytical research equipment available in the laboratories of the Department of Energy Technology will be used. I.e:

- Quantachrome Autosorb Anygas analyser for determination of surface area and pore size. Physisorb ports for micro- and mesopores and one chemisorb port;
- NETZSCH Simultaneous Thermal Analyzer STA 449 F3 Jupiter® (TGA/DSC) coupled with Quadrupole MS. Water vapor and high speed furnace (1000 K/min) and other apparatus (https://www.ttu.ee/instituut/energiatehnoloogia-instituut/teenused-22/seadmed-21/).

**Responsibilities and tasks:**

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

**Qualifications**
The applicants should fulfill the following requirements:

- Master degree in thermal, chemical or mechanical engineering
- Good speaking and writing English
- Practical experience with biomass gasification and modelling of a kinetic reaction model to predict the composition of pyrolysis products is a plus

**General info:**

*PhD studies* in Tallinn University of Technology are without *tuition* fee.

The selected candidate will be university employee/student and part of Research Group of Sustainable Energy and Fuels. The title will be Early stage researcher- PhD student. Salary/ income including scholarship is around 1100 EUR net and it is fully funded for 4 years. Health insurance coverage is available for the full nominal study period of PhD studies (4 years).

To get more information or to apply online, visit https://taltech.glowbase.com/positions/102 or scan the the code on the left with your smartphone.