

# Task-specific ionic liquids suitable for thermal energy storage and their thermal properties

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## Summary

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*Thermal energy storage (TES) materials are expected to play a vital role in future energy systems. The aim of the Ph.D. project is to study task-specific ionic liquids (TSILs) applicable as latent heat thermal energy storage (LHTES) materials. Specifically, TSILs will be synthesized and the properties relevant to TES will be measured. The obtained data will be used to evaluate the effect of the structure of TSIL on its properties to find the most promising TSILs for TES.*

Research field:	Chemical, materials and energy technology
Supervisors:	Dr. Oliver Järvik Mihkel Koel
Availability:	This position is available.
Offered by:	School of Engineering Department of Energy Technology
Application deadline:	Applications are accepted between October 02, 2023 00:00 and October 23, 2023 23:59 (Europe/Zurich)

## Description

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One of the keys for achieving the climate goals set by the European Commission is the successful combination of different energy resources and the reduction of thermal energy losses. Waste energy is a significant source of thermal energy losses. A promising technology for its reduction is energy storage and short-distance transportation to consumers utilizing latent heat thermal energy storage (LHTES). More importantly, it can also be used to provide electricity and heat cogeneration in combination with Organic Rankine Cycle solutions and Stirling engines.

For successful application of LHTES, the LHTES materials need to have favorable properties: high energy and power density, suitable physico-chemical properties, and low cost. A class of “green” materials considered applicable for LHTES application is ionic liquids (IL). As trillions of ILs could be created, the selection is further narrowed to ILs having a melting point suitable for storing low-temperature waste heat. ILs are not well studied, and the data about their properties is scarce. The proposed Ph.D. project studies TSILs, considering the ease of their synthesis and the availability of relatively inexpensive and safe starting materials. The focus will be on the thermophysical properties (thermal conductivity, heat capacity, melting point, heat of fusion, density) of synthesized TSILs, the enhancement of these properties, as well as the effect of thermal cycling on these TSILs.

It is expected that the project addresses the following essential research questions: How is the thermal stability of TSILs affected by the structure? How does the structure affect some thermophysical properties (thermal conductivity, heat capacity, melting point, heat of fusion, density) and thermal stability of TSILs? To what extent is it possible to improve the thermal properties using additives? How is thermal cycling affecting TSILs?

### **Responsibilities and (foreseen) tasks**

- Synthesis and analysis of TSILs
- Characterization of TSILs and measurement of properties of TSILs
- Working with literature
- Design of experiments and experimental setups
- Giving recommendations for better organization of work
- Collaboration with other Ph.D. students and colleagues in the department
- Supervision of BSc and MSc students

### **Applicants should fulfil the following requirements:**

- a master's degree in chemistry, chemical engineering, material science related to the project topic
- a clear interest in the topic of the position
- experience in the analytical techniques for the characterization of ionic liquids and analytical techniques for measuring thermophysical properties

- excellent command of English
- 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 assist in organizational tasks relevant to the project

**The following experience is beneficial:**

- Interest in interdisciplinary research
- Programming in Python
- Knowledge in the machine learning

The candidate must submit a conceptual research plan, including a list of possible candidate materials for the synthesis of TSILs. The candidate can expand the listed research questions and tasks.

**We offer:**

- 4-year Ph.D. 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.

For further information, please contact Senior Researcher Oliver Järvi [oliver.jarvik@taltech.ee](mailto:oliver.jarvik@taltech.ee) or visit <https://taltech.ee/en/department-energy-technology>



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