

# Enhancement of thermal properties of amine-based protic ionic liquids and their performance as LHTES materials

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## Summary

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*The overall goal of the project is to synthesize, study, and find ways for improving the properties of amine-based protic ionic liquids (PILs) for their potential application as latent heat thermal energy storage (LHTES) materials. The project addresses the following research questions: How is the thermal stability of amine-based PILs affected by the structure? How does the structure affect some thermal properties (specific heat capacity, thermal conductivity) of amine-based PILs? To what extent is it possible to improve the thermal properties using additives? How is thermal cycling affecting the PILs? How do the PILs behave in a confined matrix?*

Research field:	Chemical, materials and energy technology
Supervisors:	Prof. Dr. Alar Konist 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, 2023 00:00 and June 30, 2023 23:59 (Europe/Zurich)

## Description

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One of the keys for achieving the policy initiatives 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, and low cost. Consequently, materials with favorable properties for LHTES have to be found. A class of "green" materials considered suitable for this is ionic liquids (IL). As trillions of ILs could be possibly created, the selection is further narrowed to amine-based protic ionic liquids (PILs). These materials are not well studied and the data about their properties is scarce. The proposed PhD project deals with the study of amine-based protic ionic liquids, with the main focus on the study of their thermal properties (thermal conductivity, heat capacity), the enhancement of these properties, the effect of thermal cycling on these PILs and the behavior of PILs when they are confined in porous matrices.

It is expected that the project addresses the following research questions: How is the thermal stability of amine-based PILs affected by the structure? How does the structure affect some thermal properties (specific heat capacity, thermal conductivity) of amine-based PILs? To what extent is it possible to improve the thermal properties using additives? How is thermal cycling affecting PILs? How do the PILs behave in a confined matrix?

### Supervisors:

Main supervisor: Dr. Oliver Järvik  
Co-Supervisor: Prof. Dr. Alar Konist

### Responsibilities and (foreseen) tasks

- Synthesis and analysis of PILs
- Characterization of PILs and measurement of properties of PILs
- 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

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

- a master's degree in chemistry, chemical engineering, material science or other engineering subjects 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 thermal 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 should submit a research plan for the topic, including the overall research and data collection strategy and possible titles of at least three articles to be published on the project topic. The candidate can expand on the listed research questions and tasks.

### **We offer:**

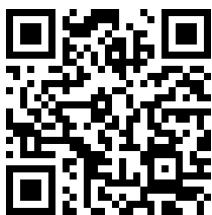
- 4-year PhD position in the Department of Energy Technology in Tallinn University of Technology
- The chance to focus on a high-level research
- Opportunities for conference visits, research stays and networking
- In case of interest, the opportunity to participate in other project applications and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